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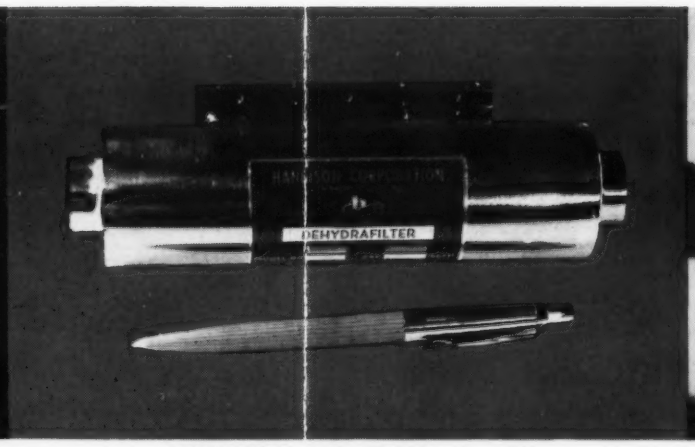
THE MAGAZINE OF Systems Engineering

RELIABLE VALVE DESIGN 182



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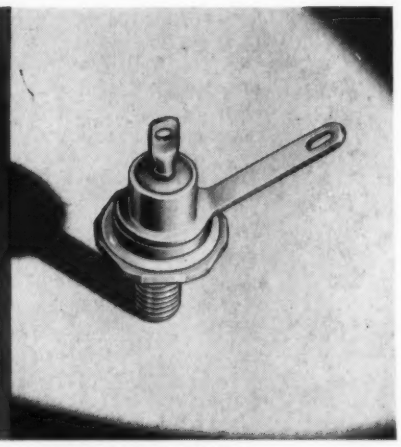

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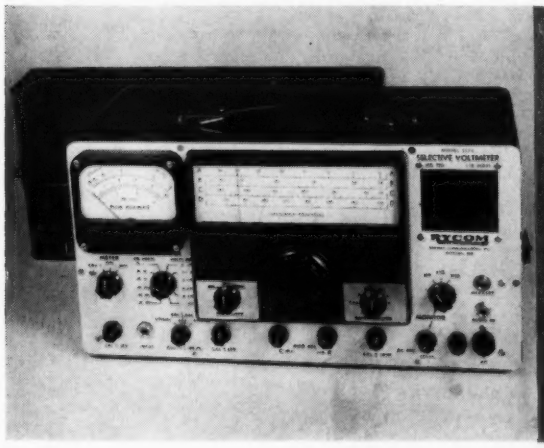

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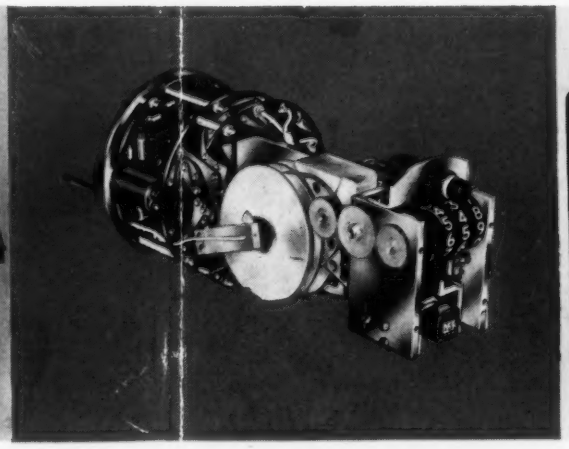

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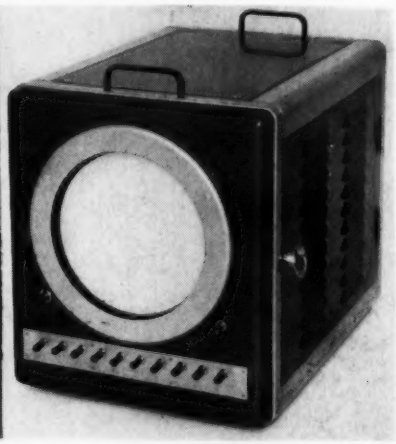

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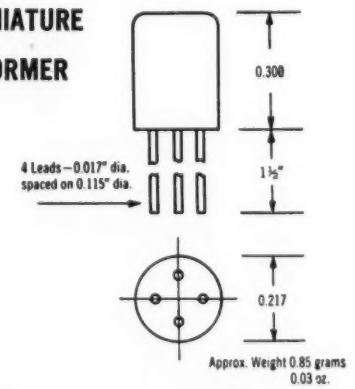

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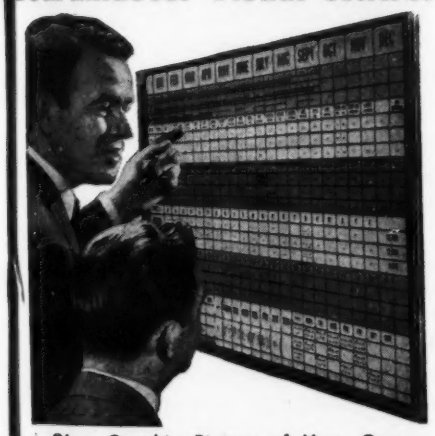

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MA military automation

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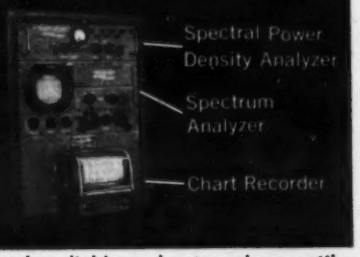

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MA Editorial

Excerpts from the keynote speech delivered by Maj. Gen. Corderman, Commanding General, Fort Monmouth, N. J. at opening ceremonies of the 4th International Automation Exposition, New York City, June, 1958. We regret that space limitations prevent the printing in full of this informative and inspiring address.

AUTOMATION FOR PEACE

IT IS a pleasure and privilege for me to address this distinguished audience this morning, and to welcome the world's leaders in automation. This field of science and technology, destined to touch upon nearly every phase of man's existence, is the focus of some of the world's greatest engineering and scientific minds today. So large an audience from nearly every corner of the globe not only reflects keen world-wide interest, but points up the coming full maturity of a technology that only a few years ago was a subject lexicographers could not agree upon, and social scientists worried about.

* * *

We have applied automation in great measure to our defense effort, resulting in a multiple series of benefits. For example, in electronic circuit fabrication we have both devised and applied a technique that turns out better equipment faster, with less effort, at less cost, and with less materials. (The General then gave specific examples of the Army's use of automation in problems of invasion planning, in ballistics research, inventory control and procurement of maintenance parts, personnel management and duty assignments, and the control of freight and personnel traffic over airlines and railroads.)

* * *

From the brief examples I've given here today you can see that automation has given the Army capabilities which have revolutionized logistics, administration, production and tactical operations. Automation has made it possible for military commanders to make wise decisions based on a concise assembly of salient facts, derived instantly from maximum sources.

But a *still greater* understanding and engineering ingenuity in the use of automation concepts is certainly of continuing military interest. And the fruits of new knowledge in this field gained from military research will continue to benefit world-wide industry and commerce as a secondary dividend of defense. It will make possible better and lower cost products for modern man. And these will be turned out with less human effort.

* * *

Some may ask: "Where do we go from here?"

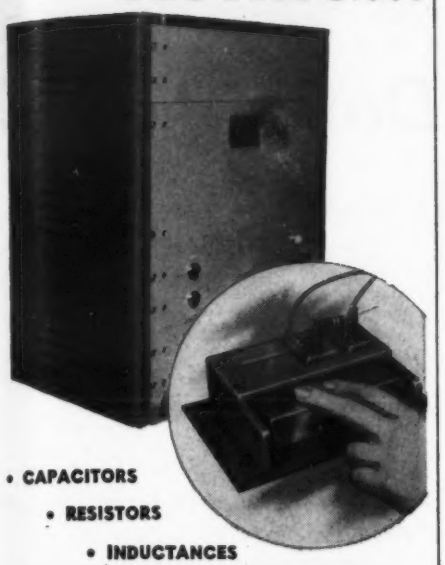
In times of international stress and strain who can say for sure. The parameters of global peace and understanding have so far defied the scientist's logic and techniques. Truly the machine-age has made available the most amazing devices for insuring peace. These remarkable machines of instant mass-destruction stand poised against each other, symbolizing mankind's highest plateau of scientific achievement; on one hand guaranteeing his continued existence, on the other threatening his extermination: an eerie combination of accomplishment, bewilderment and fear.

MAJ. GEN. W. PRESTON CORDERMAN (second from left) is congratulated on his address by General Paolo Supino (left), Italian Air Force; Mr. Anthony B. Akers, Dept. of Commerce, State of New York; and Mr. Richard Rimbach, Manager, 4th International Automation Exposition.

In this age of scientific breakthroughs and exploration of phenomena far beyond our dreams of only a short time ago, mankind now has at his disposal the means for eliminating want and the incentive for war. He can raise himself above the primitive struggle for survival which has haunted him from time immemorial.

Wouldn't the automationist reach the peak of accomplishment if he could design a sort of international computer and control system into which would pour all significant information in raw data form from nations around the world, and which could be programmed for workable solutions toward continued peace, and friendship? I think you'll agree that, like ATOMS FOR PEACE, AUTOMATION FOR PEACE could become another common denominator for the betterment of all mankind—by elimination of all want through increased productivity.

HIGH SPEED TESTING...



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Fast Slewing Computer

New GEVIC (General Electric Variable Increment digital Computer), because it can select the size of the applied increments to correspond with the speed with which the problem is changing (Fig. 1), can outstrip fixed increment computers. Fast dynamic inputs, such as those encountered in high-performance fire control and guidance systems, are followed with slew rates up to 3200 units per second. High reliability, regardless of temperature and voltage variations, is said to be achieved by employment of all solid-state components; magnetic core-diode logic units are used throughout the arithmetic section, and silicon transistors are used for the read, write and clock amplifiers.

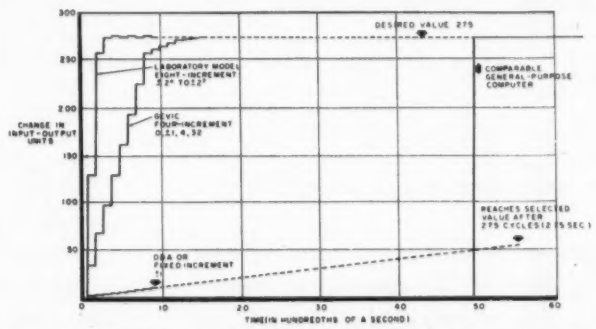
DESIRED VALUE 275
LABORATORY MODEL EIGHT-INCREMENT 0.2° TO 12°
COMPARABLE GENERAL-PURPOSE COMPUTER
GEVIC FOUR-INCREMENT 0.01, 4, 32
CHANGE IN INPUT-OUTPUT UNITS
REACHES SELECTED VALUE AFTER 275 CYCLES (2.75 SEC)
DDA OR FIXED INCREMENT
TIME IN HUNDREDTHS OF A SECOND

FIG. 1. GEVIC VARIABLE INCREMENT computers are compared with fixed increment computer of same iteration rate (100 cps) and with general purpose computer (iteration rate, 2 cps).

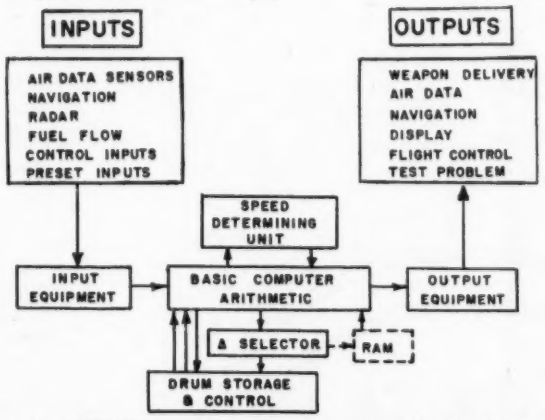

FIG. 2. GEVIC modular design permits flexibility in specific applications to a wide range of functions.

GEVIC can be applied to many missile guidance and control systems, including the launch computer function. For simple missile navigation applications where digital accuracy is needed, a scaled-down version of GEVIC can be used. For high performance aircraft GEVIC can perform the central computer function in all or part of the following jobs: Weapon delivery, navigation (including doppler-inertial or fully inertial systems), fuel management, data link decoding and encoding, flight control steering signals, flight control relief mode signals, and display computations (Fig. 2).

Using modular units designed for forced-air cooling, GEVIC occupies less than 2 cu-ft of space, weighs 70-90 lbs, depending on the input-output equipment required. (*From 2-page bulletin 425M2, Light Military Electronics Department, General Electric, French Rd., Utica, N. Y.*)

For more information on GEVIC circle **101** on inquiry card.

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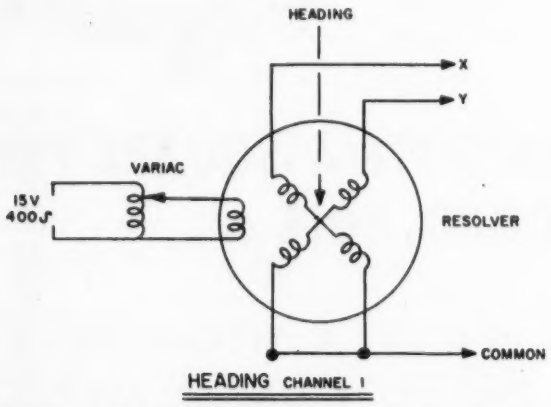
FIG. 1. POLYSCOPE display system for trainer, testing and control applications enables the simultaneous display of up to ten separate variables on single scope.

Single Scope Displays Ten Data Channels

THE Polyscope CRT display system (Fig. 1), designed for applications in sonar or radar trainers, wind tunnel testing, structure testing, etc., is capable of accommodating up to ten separate and independent variables, each shown as a movable spot positioned by rectangular or polar coordinate inputs. It also can be readily combined with a tape recording system for later reproduction and presentation of display data.

A typical application for display of aircraft data is shown in Fig. 2. Here seven independent parameters are combined in one easily read display for either aircraft or ground control purposes. Notice that in this instance an engraved mask is used over the face of the scope so that channel dots must move in prescribed paths.

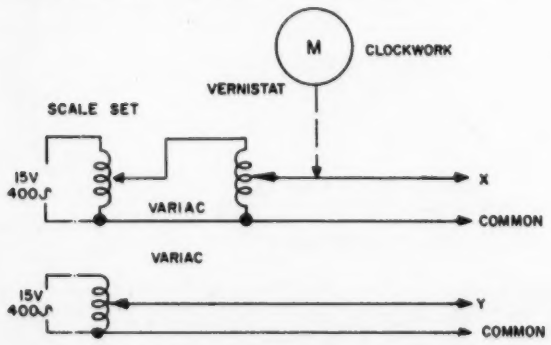
Signal sources are resolvers, Variacs, Vernistats and potentiometers, with typical input circuits as shown in Fig. 2. The positioning of the heading spot is accomplished by polar coordinate inputs. The radius of the spot position is determined by the setting o



HEADING CHANNEL 1

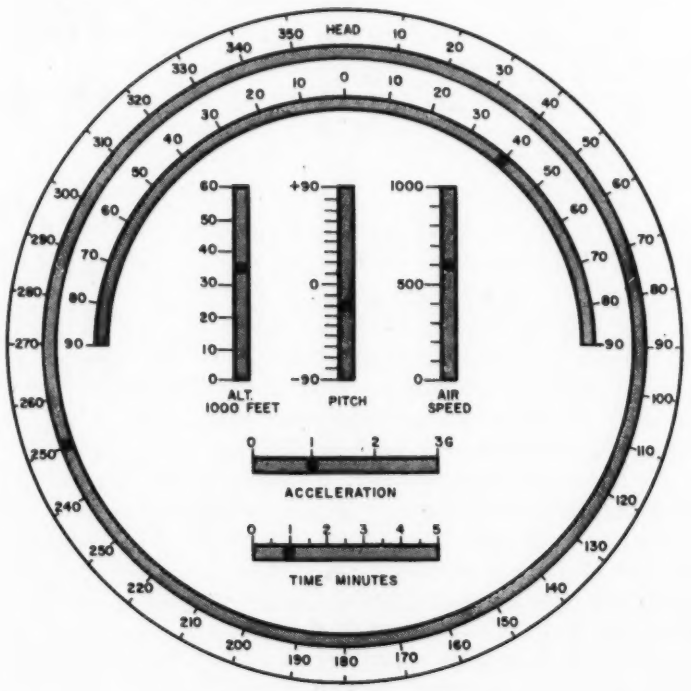
Variac and resolver produce X-Y inputs for circular tracks of Heading and Roll.

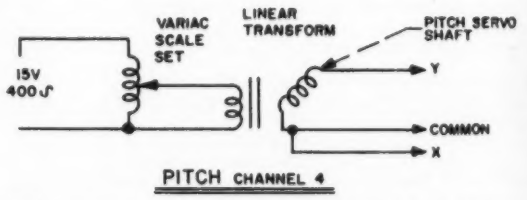
Two Variacs and a Vernistat position and set scale for horizontal tracks of Time and Acceleration.



TIME CHANNEL 3

FIG. 2. AIRCRAFT DATA from seven inputs are simultaneously displayed as illuminated spots on horizontal, linear and circular scales. Typical circuits for generating inputs are shown in schematics.

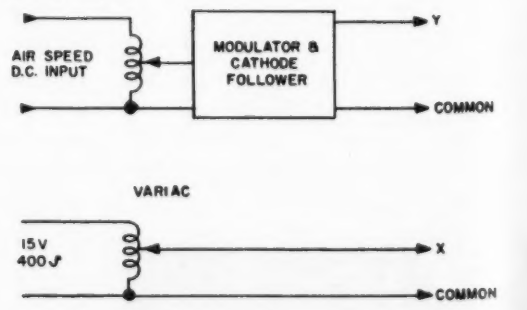




PITCH CHANNEL 4

Pitch servo actuates linear transformer to produce Y input. Display is horizontally centered so no X input is needed.

DC input from air speed transducer is modulated and impedance transformed by cathode follower. X position is set by variac. Similar circuit is used for altitude input.



AIR SPEED CHANNEL 5

A. Schlang,
Head, Simulator & Video Section

E. Scharf,
Senior Electrical Engineer,
Waldorf Instrument Co.,

the Variac, which is adjusted for test set-up. The resolver shaft position then determines the spot angle. In Channels 3 and 5, a Variac is used to position the rectangular parameter to be held constant, while the variable input is furnished by a Vernistat or a variable potentiometer. In channel 5, no X input is required since the display is horizontally centered. The vertical deflection is produced by a linear transformer rotated by a servo shaft. The scale factor is set by the Variac.

Polyscope Operation

The block diagram, Fig. 3, illustrates the operation of the Polyscope. The scope operates on a 400 cps carrier frequency which controls the sequential selection of the input channels, and the beam blanking during switching intervals. Ten time-sequenced gating waveforms are developed by the magnetron waveform generator. These waveforms, operating through the channel matrices, sequentially select one channel at a time for display. The gating waveforms are also selectable for blanking particular channels.

Since the CRT is only momentarily turned on during peak spot displacements, the scope accurately displays sine-wave amplitude data. In effect, the CRT itself acts as a phase detector.

Special Features

Identification of the individually displayed channels is accomplished by a set of switches. As each channel switch is depressed the corresponding spot will extinguish. Slow automatic blinking of the spot can be incorporated for visual identification of a selected channel. Cathode Ray Tubes with long persistence phosphors or special memory features can be incorporated in the Polyscope to retain images for as long as several days, if desired.

The standard unit has a magnetic tape recorder which can be employed as accessory equipment to record the information displayed on the Polyscope and to play this information back at a later time. Only

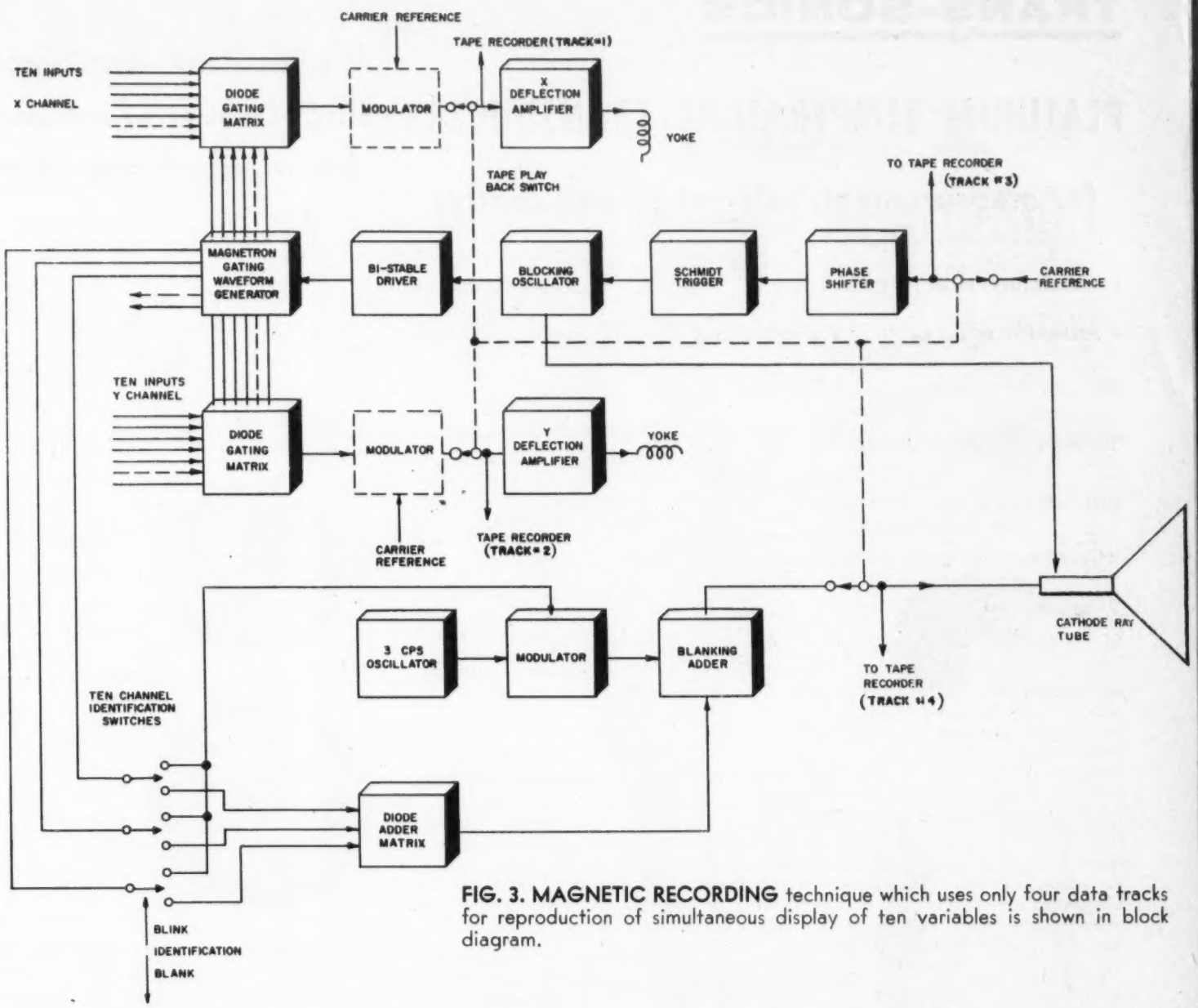


FIG. 3. MAGNETIC RECORDING technique which uses only four data tracks for reproduction of simultaneous display of ten variables is shown in block diagram.

four tape tracks are required for this use, because the multiplexed data, rather than the separate channels, are recorded (Fig. 3). One tape track records the multiplexed X position data while a second track records the multiplexed Y position data. A third track records the carrier reference signal used in decoding the multiplexed position data. Since the carrier reference is recorded along with the position data, the effects of tape stretch are minimized. A fourth track records channel identification signals used during the initial examination of the data.

FM techniques are used in recording position data, which permits storage of tapes indefinitely without degredation of recorded data. Additional circuitry can be added to permit the polyscope to accept 20 inputs from two coordinate channels. If a 400 cps carrier is used with 20 inputs, a 20 cps flicker will result on the standard unit. However, this may be minimized by the use of long persistence phosphors.

Input Elements

The standard Polyscope accepts 400 cps information. Equipment is available to convert both dc and ac signals of any arbitrary frequency to the 400 cps carrier frequency so that the scope can accept a wide variety of inputs. Typical signal sources are variable resistance and variable reluctance transducers, such as strain gages, accelerometers, thermocouples, resolvers, differential and linear transformers, etc. The input impedances of the polyscope data channels are nominally 60,000 ohms which should be taken into account in high accuracy measurements.

Anticipating that the Polyscope will prove adaptable to a wide variety of display applications, its developers, the *Electronics Division of the Waldorf Instrument Co., Huntington Station, Long Island, N. Y.*, will be pleased to discuss specific adaptations of the instrument to research, testing or industrial control with interested persons.

For more information on the Polyscope circle **102** on inquiry card.

TRANS-SONICS

REG. T.M.

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- TEMPERATURES FROM −425 TO +1832 F.
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- ACCURACIES TO 0.1 F.
- 5 VOLT OUTPUT
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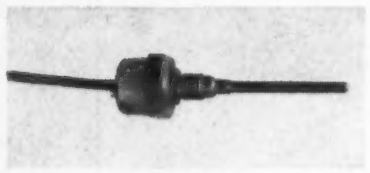
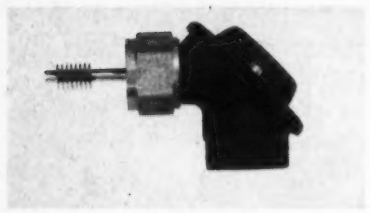


1300 Series

BULB TYPE for corrosive gases and liquids

1300 Series transducers are available in ranges from −400 F to +1832F, feature 1% accuracy, stainless-steel construction, and a time constant of less than 2.5 seconds in agitated liquid. Many standard and special bulb lengths are available.



Type 2135

Type 2135 has ±0.25 F accuracy and interchangeability over a range of 0 to +125 F. The platinum element is enclosed in a nickel-plated bulb, and the unit will withstand a working pressure of 4500 psi.

OPEN TYPE for non-corrosive gases and liquids

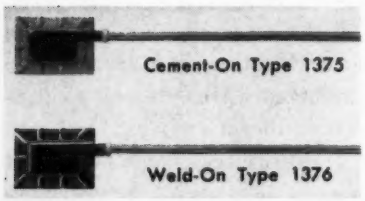
1350 Series

Type 1321

1350 Series transducers are available in ranges from −300 F to +600 F, with an accuracy of ±1% full scale. The platinum sensing element comes in direct contact with the gas or liquid being measured, resulting in a typical response time of 0.2 second in agitated liquid.

Type 1321 is designed for extreme low temperature measurements, with special calibrations to −425 F. Operating interval is 30 F in ranges up to +250 F, with ±1% accuracy. A perforated shield protects the platinum sensing element from high flow rates.

SURFACE TYPE for all kinds of surfaces



These platinum temperature transducers can be installed by a variety of methods on any surface . . . flat or curved, metallic or non-metallic. The following types are available in ranges from −400 F to +1850 F: Cement-On, Weld-On, Tape-On, Thermopaper, Sub-Surface, and Surface Transferable.

A five-point resistance-temperature calibration certificate at 0, ¼, ½, ¾, and full scale temperature is supplied with each transducer. Custom designs for all temperature transducers are available on special order with accuracies to 0.1 F. Write to Trans-Sonics, Inc., Dept. 12, Burlington, Mass. for Condensed Catalog on Platinum Temperature Transducers.

TRANS-SONICS

Precision Transducers

For more information circle **9** on inquiry card.

Miniaturized Analog-to-Digital Shaft Converter Increases Resolution, Eliminates Ambiguity

Previous methods of analog-to-digital shaft conversion employed in telemetering, computing and testing systems, have required a least-significant bit track diameter of at least seven inches to provide 10-bit resolution. A new disc pattern, developed by Librascope, Inc., now uses ten output brushes, six feed brushes, and one common brush combined with built-in transistorized logic circuits to achieve 10-bit resolution with a disc only 3½" in diameter. (Fig. 1)

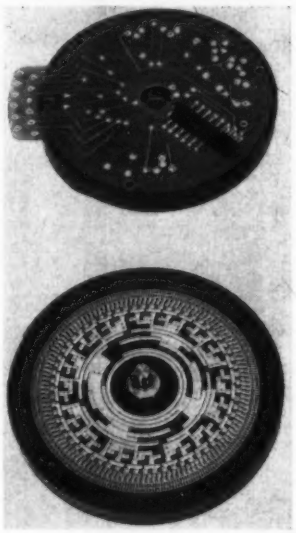


FIG. 1. MINIATURE ANALOG-TO-DIGITAL shaft converter achieves 10-bit resolution without ambiguity with disc only 3½ inches in diameter.

FIG. 2. STAGGERED TRACKS provide high resolution; transistorized logic circuits built into disc eliminate ambiguity by making least-significant bits control transition of all other bits.

High resolution in one-half the minimum diameter previously considered practical is accomplished by employing two tracks, each with one-half the required resolution, instead of one track with 10-bit resolution. The two tracks are staggered by one-half segment with respect to each other. Signals from the two brushes contacting these tracks are combined logically to form the least significant bit with the required 10-bit resolution. Ambiguity is controlled by preventing transition of any of the nine most-significant bits except coincidentally with the least-significant bit.

Brush wear and current capacity impose a minimum size limitation on brush size and hence on the minimum size of the segments used to provide the least-significant bits. Ambiguity may result if all brushes and segments involved in each position change do not make and break contact simultaneously. Ambiguous signals generated by non-simultaneous contacting can produce errors in computation or cause mal-functioning in equipment which is dependent on the conversion.

The new Librascope disc pattern (Fig. 2) provides each of the normally-conducting segments, except those for the least-significant bits, with a leading and lagging portion, each electrically isolated from the permanently energized portion of the segment. The

FREED TELEMETERING COMPONENTS

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BAND PASS FILTERS

Catalog No. Z_o=500Ω	Catalog No. Z_o=2,500Ω	3DB Bandwidth per cent of F_o ± 9¾	3DB Bandwidth per cent of F_o ± 19½	Center Frequency F_o (KC)
FBP-10	FBP-34	V		.4
FBP-11	FBP-35	V		.56
FBP-12	FBP-36	V		.73
FBP-13	FBP-37	V		.96
FBP-14	FBP-38	V		1.3
FBP-15	FBP-39	V		1.7
FBP-16	FBP-40	V		2.3
FBP-17	FBP-41	V		3.0
FBP-18	FBP-42	V		3.9
FBP-19	FBP-43	V		5.4
FBP-20	FBP-44	V		7.35
FBP-21	FBP-45	V		10.5
FBP-22	FBP-46	V		12.3
FBP-23	FBP-47	V		14.5
FBP-24	FBP-48	V		22.0
FBP-25	FBP-49		V	22.0
FBP-26	FBP-50	V		30.0
FBP-27	FBP-51		V	30.0
FBP-28	FBP-52	V		40.0
FBP-29	FBP-53		V	40.0
FBP-30	FBP-54	V		52.5
FBP-31	FBP-55		V	52.5
FBP-32	FBP-56	V		70.0
FBP-33	FBP-57		V	70.0

DISCRIMINATORS

Per cent Deviation of F_o 8½	Per cent Deviation of F_o 15.	Per cent Linearity 0.5	Per cent Linearity 1.0	Catalog No.
V		V		DST-10
V		V		DST-11
V		V		DST-12
V		V		DST-13
V		V		DST-14
V		V		DST-15
V		V		DST-16
V		V		DST-17
V		V		DST-18
V		V		DST-19
V		V		DST-20
V		V		DST-21
V		V		DST-22
V		V		DST-23
V		V		DST-24
	V		V	DST-29
V		V		DST-25
	V		V	DST-30
V		V		DST-26
	V		V	DST-31
V		V		DST-27
	V		V	DST-32
V		V		DST-28
	V		V	DST-33

DISCRIMINATOR LOW PASS FILTERS

Catalog No.	Center Frequency F_o (cps)	Catalog No.	Center Frequency F_o (cps)	Catalog No.	Center Frequency F_o (cps)	Attenuation
OUTPUT						
LPO-10	6	LPO-19	81	LPO-28	790	
LPO-11	8	LPO-20	110	LPO-29	900	
LPO-12	11	LPO-21	160	LPO-30	1,050	
LPO-13	14	LPO-22	185	LPO-31	1,200	
LPO-14	20	LPO-23	220	LPO-32	1,600	
LPO-15	25	LPO-24	330	LPO-33	2,100	
LPO-16	35	LPO-25	450	LPO-34	7,200	
LPO-17	45	LPO-26	600	LPO-35	10,000	
LPO-18	60	LPO-27	660			
Characteristic impedance of all=330Ω						
INPUT						
LPI-10	400	LPI-17	3,000	LPI-23	14,500	
LPI-11	560	LPI-18	3,900	LPI-24	22,000	
LPI-12	730	LPI-19	5,400	LPI-25	30,000	
LPI-13	960	LPI-20	7,350	LPI-26	40,000	
LPI-14	1,300	LPI-21	10,500	LPI-27	52,500	
LPI-15	1,700	LPI-22	12,300	LPI-28	70,000	
LPI-16	2,300					
Characteristic impedance of LPI-10 thru 23=30,000Ω of LPI-24 thru 28=5,100Ω						

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MILITARY AUTOMATION

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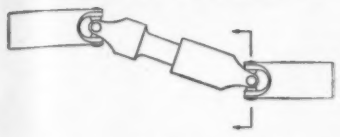

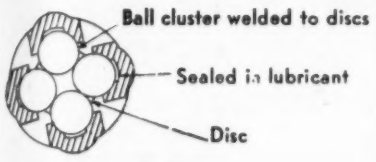

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• Zero backlash • Maximum operating angle of 30° • Lightweight • Sealed-in Lubrication

SINGLE JOINT DIMENSIONS

Pt. No.	Bore	Body	Length	Torque In. Oz.	Price 1-9
8BS	Solid	3/16	1-1/32	4	$4.35
1BS	.0938	3/16	"	"	$4.65
2BS	.125	"	"	"	"
3BS	.156	9/32	1-3/8	16	4.55
4BS	.1875	"	"	"	"
5BS	.2188	3/8	1-3/4	64	4.50
6BS	.250	"	"	"	"

Literature available

FALCON MACHINE & TOOL CO., INC.
210 Concord Turnpike, Cambridge 40, Mass.

For more information circle **11** on inquiry card.

For your library . . .

Printed Circuitry

by Allan Lytel. A valuable working tool; includes alternative and recommended practice for each step in design and production of printed circuits; a buyer's guide to special components; and "how to" service data. Paperboard, illustrated, 192 pages, 1957. $2.00

Maintenance and Servicing of Electrical Instruments

by James Spencer. Useful to all instrument users, service men, switchboard attendants testing engineers, and others, this book covers construction, testing, applications, principles of operation and maintenance of all kinds of electrical indicating instruments. Clothbound, 274 illustrations, 280 pages, 1951 (third edition). $2.00

Process Control Analysis

by M. H. LaJoy and E. A. Baillif. An essential first step in analysis of closed-loop controlled processes via frequency response of the system. Clothbound, 72 pages, 1956. $2.00

Instruments Publishing Co., Inc.

845 Ridge Avenue

Pittsburgh 12, Pa.

least-significant bit segments act as controlling bits, determining the exact moment of transition of the more-significant bits. When an output brush is to be energized, it first contacts the leading portion of the conducting segment. This leading segment is energized as its controlling bit undergoes transition. The brush then contacts the permanently energized portion of the segment and remains in contact with this portion of the segment until rotation of the disc determines that the brush should be de-energized. Just before the brush reaches this position, it leaves the permanently energized portion of the segment and contacts the isolated lagging portion of the segment, which is energized from its controlling least-significant bit. As the controlling bit makes its transition, the isolated lagging portion is also de-energized, de-energizing the output brush. In this manner, the transition of a single brush on each track is dependent on the simultaneous transition of the controlling bit, and ambiguous outputs due to time difference in bit transition are eliminated.

Diode connections are used to isolate the feed brush from the controlling bit, and a P-N-P transistor logic circuit forms the complement function of the controlling bit, used to energize the isolated leading portion of following segments the instant the controlling bit is de-energized.

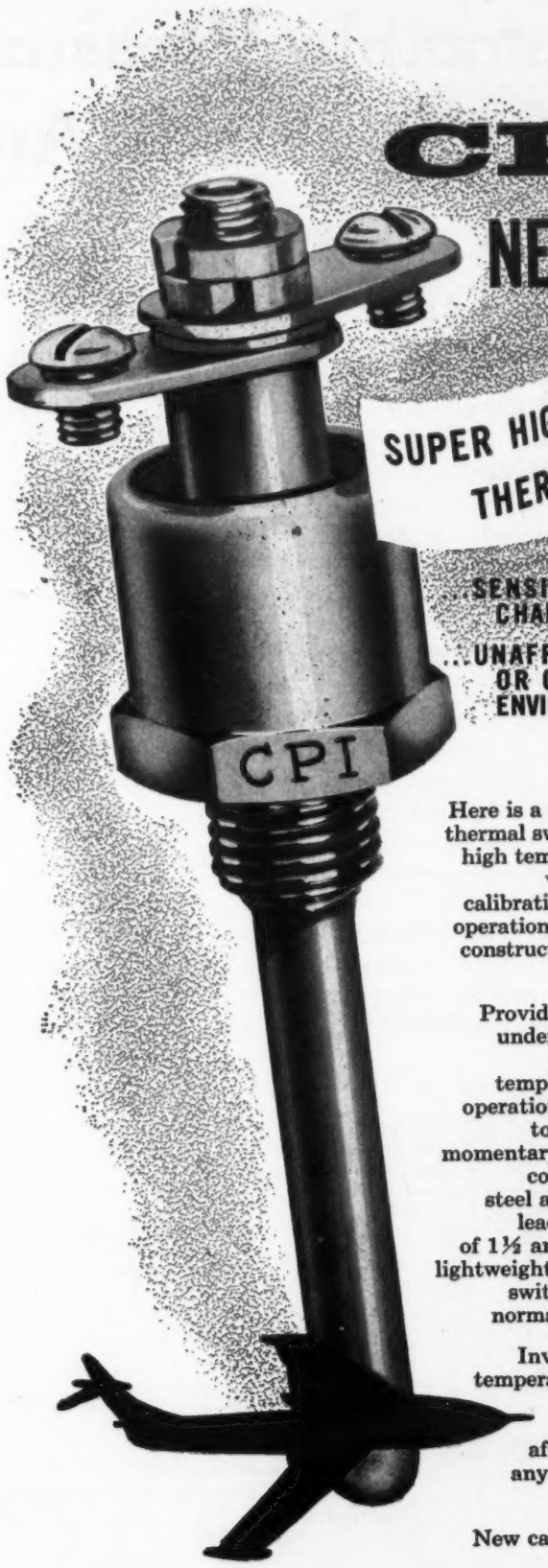
The unique disc pattern and integral transistor circuitry thus eliminate ambiguity without resorting to double brush systems, double disc patterns or external logic circuits. Reduction of the dimensions of shaft position encoding converters is particularly significant in aircraft and missile telemetering applications, but will also find applications in automatic machinery, chemical processes, etc., where the small component will more readily fit into existing equipment designs. The new shaft converter is a development of Librascope, Inc., 808 Western Ave., Burbank, Calif.

For more information on the Shaft Converter circle **103** on inquiry card.

BOOK REVIEWS . . .

HOT LABORATORY EQUIPMENT, 2nd Edition 1958; compiled by Louis G. Stang, Jr., Brookhaven National Laboratory, U. S. Atomic Energy Commission. Enlarged over 1955 edition, 429 p. 351 illustrations, 8½" x 11", Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C. $2.50. Gives detailed descriptions and design data for facilities, equipment and accessories used in handling moderate to large amounts of radioactive materials.

PRECISION MICROWAVE/ULTRAMICROWAVE EQUIPMENT. Catalog C3, (c1957) DeMornay-Bonardi Corp., 780 So. Arroyo Parkway, Pasadena, Calif. 268 p. $2.50. 8½" x 11". Includes reference sections, Introductory Concepts (9 p.), Manual of Microwave Measurements and Calibration (42p.), and Handbook of Waveguide Reference Data (76p).



CPI's NEW DESIGN

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Here is a new super high temperature thermal switch designed for extremely high temperature applications where very high, close temperature calibration is required with repeated operations. And, its rugged, compact construction provides high resistance to vibration.

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For more information circle **12** on inquiry card.

Programmable Pressure Regulator Aids Check-out Automation

MISSILE and aircraft check-out operations can be facilitated—even automatically programmed in predetermined sequences—using a new solenoid-operated pressure regulator for inert gases, Type RV-23E (Fig. 1), just announced by the Marotta Valve Corporation, Boonton, N. J. Previous pressure control systems depending on hand operation which of necessity located the regulator valve within reach of the operator now can employ RV-23E regulators located for the most efficient pneumatic arrangement. If desirable, missile pressure can be remotely controlled from an electrical panel (Fig. 1) or programmed using standard servo and telemetry techniques.

The new valve uses the balanced poppet design, (Fig. 2), developed and used by Marotta in hand-operated regulators, which needs no heavy loading springs or restricted ports to minimize the effect of inlet pressure variations. In balanced poppet design, diameters of the main valve seat and the poppet stem are equalized, which is said to permit the use of large valve seats and to result in an increase in flow from a smaller, more compact unit.

Loading of the RV-23E is shown in Fig. 3. Setting the operating pressure (termed "loading" the regulator) is accomplished by turning power on and pushing the "load" button on the panel, which actuates solenoid A, opening the normally-closed inlet metering-valve, and solenoid B, opening the normally-closed dome metering valve. Valve C is a normally (unoperated condition) open valve which is continuously energized. This allows the pressurized gas to enter the inlet valve, flow through the dome metering valve, into the top of the piston where it fills the constant pressure dome. The piston is forced down, sealing the relief seat, depressing the balanced main poppet stem, and opening the main seat to allow gas under pressure to flow into the downstream system. It also enters the lower piston cavity where it lifts the piston up against the pressure exerted by the gas in the constant pressure dome.

When the desired pressure is attained in the downstream system the "load" button is released (or in the case of the programmed system the circuit is automatically interrupted by the feedback transducer) and the balanced condition shown in Fig. 2 with valves A, B, and C closed is maintained. If downstream pressure falls, the piston moves down, opening the main poppet seat to allow high pressure gas from the inlet to enter. As soon as the downstream pressure equals the constant dome pressure, the main seat closes to shut off inlet gas. It is interesting to note that should some reaction in the downstream system increase the downstream pressure, the piston will move up, open the relief seat, and vent the excess pressure through the screened vent. The balanced poppet system also isolates the downstream system from all variations in inlet pressure.

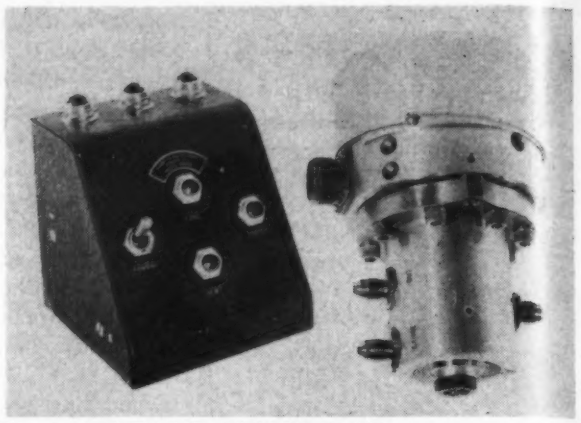

FIG. 1. SOLENOID-CONTROLLED pressure regulator can be located at any point in missile test system; manual control panel (left) is located at operator's position.

To reduce system pressure gradually the "vent" control is manually depressed (Fig. 4) and valve B operates, allowing the gas trapped in the constant pressure dome slowly to bleed through the orifice until the desired operating pressure is reached.

For shut-down or emergency venting, the "Panic Button" is pushed or power is turned off (Fig. 5). Either action interrupts current to solenoid C which releases, opening valve C. This rapidly vents the constant pressure dome, and the piston is driven to its upper excursion. The relief seat is opened wide, allowing the downstream system pressure to escape through the screened vent. However, an alternate design allowing downstream pressures to be maintained when power is interrupted is also available.

Now made in aluminum body with stainless steel, beryllium-copper and nylon parts, its capacity (0.1 SCFM/psia min.) for inert gas is equivalent to that of a ¼" line. Detailed technical information and applicable Mil-Spec information will be provided by the manufacturer upon request.

For more information on Pressure Regulator circle **104** on inquiry card.

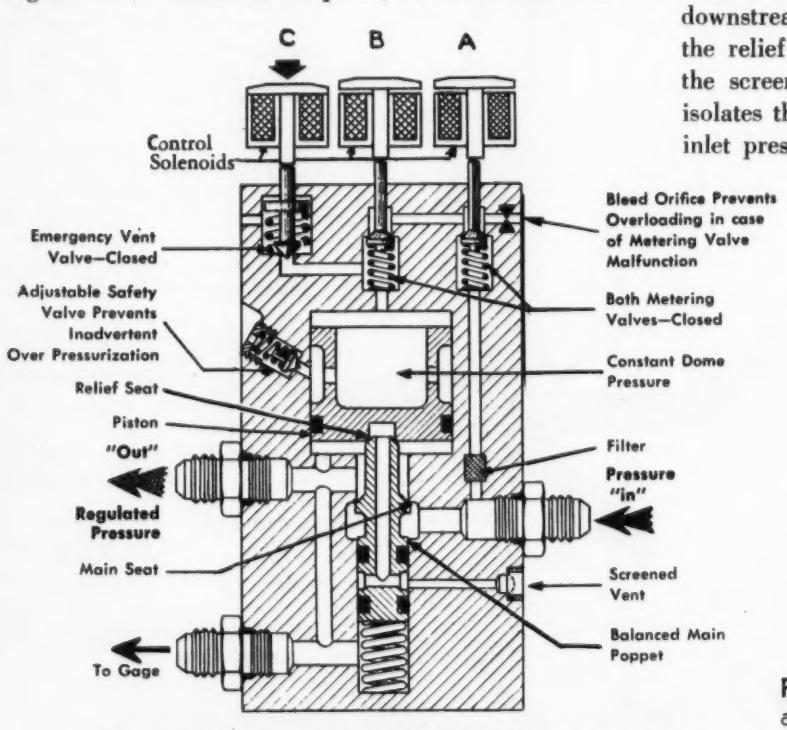

FIG. 2. VALVE IN SET POSITION. Dome pressure is balanced by outlet pressure. Any change in outlet pressure is quickly compensated by automatic opening of either main or relief seat.

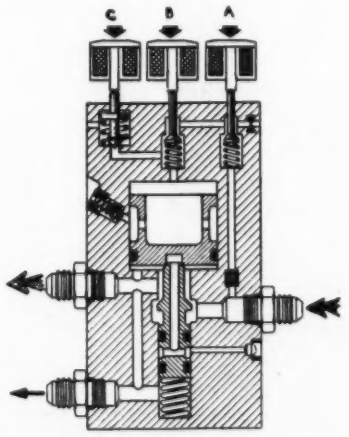

FIG. 3. LOADING. All solenoids are energized. Increasing pressure in dome closes relief seat and lifts poppet off the main seat. "Out" port pressure builds up until load button is released.

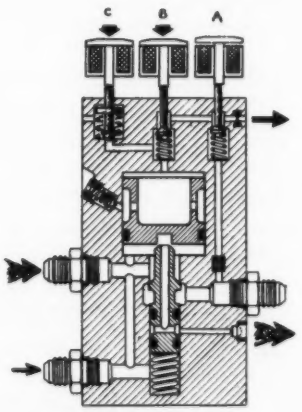

FIG. 4. VENTING. To lower set pressure, solenoids B and C are energized, allowing gas to bleed slowly through metering valve B and the orifice. Relief seat opens and vents excess downstream pressure.

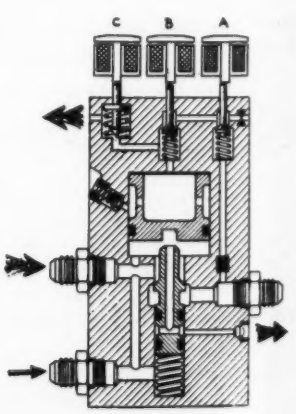

FIG. 5. EMERGENCY VENTING. Push panic button or switch power off, de-energizing all solenoids. Dome pressure decreases rapidly, relief seat opens wide to vent downstream pressure fast.

Alfred D. Gibbs,
Chief Engineer
Bradley Laboratories, Inc.

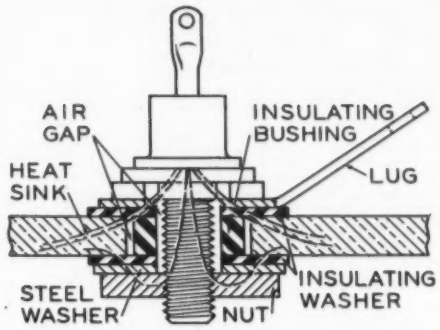

FIG. 1. HEAT FLOW paths (dotted lines) are impeded when conventional diode rectifiers are insulated from heat sink by washers and bushings; assembly costs are high.

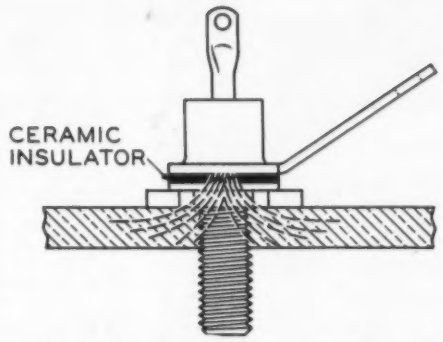

FIG. 2. BUILT-IN ceramic insulator of Bradley silicon diode conducts heat readily, affords circuit isolation and minimizes assembly costs.

Insulated Silicon Diode Gains Versatility: Retains High Capacity

THE MAXIMUM operating current of a silicon rectifier is normally limited by the rate at which heat generated by the rectifier can be dissipated rather than by the maximum current capacity of the silicon. To increase its heat dissipation rate the diode is usually mounted on a heavy copper stud which in turn can be mounted on a chassis or heat sink, thus allowing the unit to pass a higher continuous current.

However, because the stud is also one terminal of the rectifier, the number of different rectifier circuits that can be formed on a single chassis is greatly limited, and it is also impossible to electrically isolate the chassis from the rectifier. As a result the chassis is often operated at a dangerous potential with respect to ground.

If the equipment designer attempts to electrically insulate the mounting stud from the chassis, the normal procedure is to supply two insulating washers, a flat metal washer, a nut, a lug, and an insulating bushing with each diode for mounting as shown in Fig. 1. Although this insulates the diodes from the chassis and from each other, other serious problems are created:

First, the insulated washers and bushings greatly reduce the rate of heat transfer from stud base to chassis or heat sink, thereby reducing the maximum current rating of the rectifier. Variations in air gap also vary the rate of heat transfer, making it impossible to specify a thermal transfer characteristic that will remain constant from unit to unit. Another serious problem is hy-pot failure. If insulating washers are cracked or scored during assembly they may break down when high voltage is applied. Finally, the extra parts and the time required for their assembly in conventionally-insulated rectifiers greatly increase the cost of equipment fabrication.

A new stud-mounted silicon rectifier developed by the Bradley Laboratories, Inc., New Haven, Conn., solves the insulated rectifier dilemma by its new design (Fig. 2). Insulating the rectifier from the hex head of the mounting is a thin disc of high-alumina ceramic, which has a very high thermal conductivity compared to mica and most other insulating materials. By metallizing this ceramic disc and brazing it to the adjoining metal surfaces, all thermal-conductivity variables, such as air gaps, are eliminated. Consequently, the rate of heat transfer remains constant from one unit to the next and can be accurately specified. The heat transfer paths in the Bradley unit also are more direct and have less thermal resistance than in conventionally insulated diodes, which design is directly translatable into higher capacity in most applications. The method of bonding the thin insulating disc on both sides to solid metal surfaces also provides a high degree of shock and vibration resistance, an important factor in missile and other military applications.

Advantages of the Bradley insulated base silicon diode are summarized as allowing a number of units to be mounted on the same heat sink to form any desired circuit; more reliable operation at higher current ratings, and significant savings in hardware and assembly costs.

For more information on the Silicon Diode circle **105** on inquiry card.

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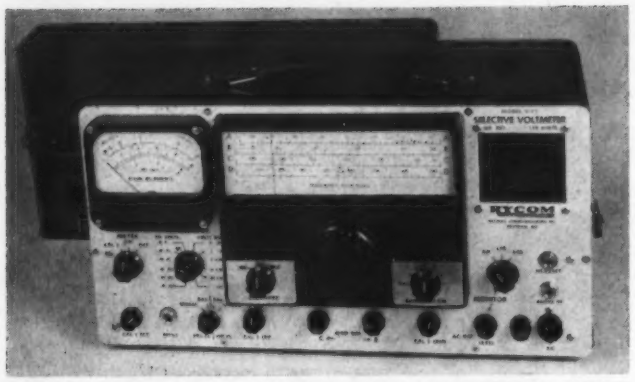
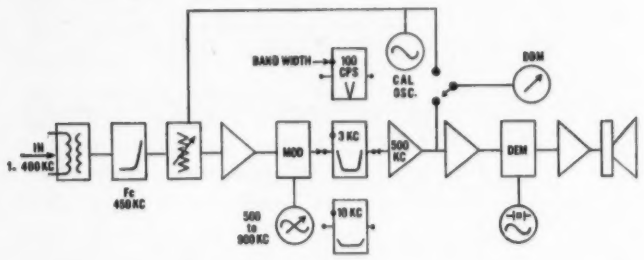


FIG. 1. PORTABLE FREQUENCY-SELECTIVE VOLTMETER, comprising tunable filter and broad-band voltmeter, permits accurate voltage measurements on each channel of frequency-division multiplex systems.

FIG. 2. SINGLE HETERODYNE CIRCUIT is designed for elimination of image responses, wide spectrum coverage, and accuracy in calibration.



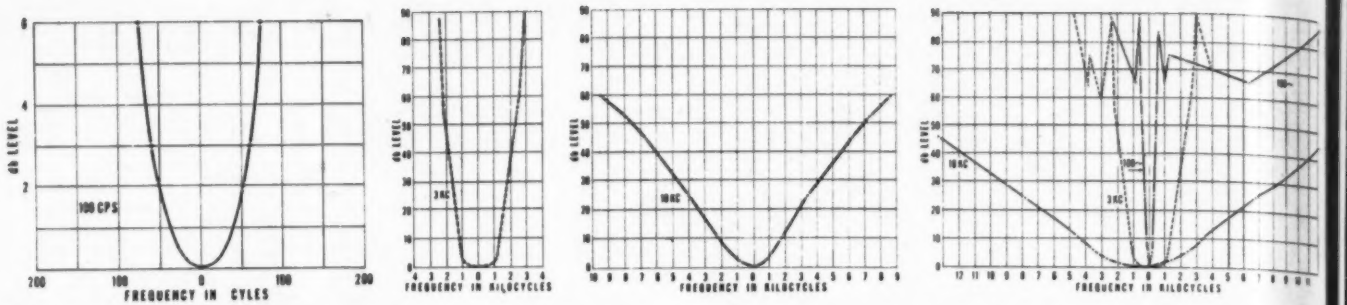


Fig. 3. FILTER RESPONSE CURVES of Model 2174 Frequency Selective Voltmeter: (a) 100 cps crystal filter; (b) 3,000 cps crystal filter; (c) 10,000 cps filter; and (d) superimposed filter curves.

Selective Voltmeter for Frequency Division Multiplex

F. M. BERRY, Chief Engineer, Railway Communications Inc.

A FREQUENCY-selective voltmeter is proving an economical and time saving instrument in the maintenance and design of frequency division multiplex systems.

Frequency division multiplex is increasingly being used for transmission of voice, telegraph, telemetry, etc., signals over wire line, cable, radio and microwave circuits. A multiplicity of channels, each allocated its specific band of frequencies, are combined at the transmitting end of a circuit and are transmitted over a base band channel whose width encompasses the frequency spectrum of all channels. After being transmitted, individual filters select each channel.

A base band circuit with its multiplicity of channels may extend hundreds of miles and is subject to transmission losses, noise and distortion. Amplitude nonlinearity in the base band introduces intermodulation and causes noise and cross-talk between channels. To facilitate the adjustment of levels and measurement of noise and cross-talk at various points throughout the base band it is desirable to be able to measure the signal level of each individual channel without interference from signals in other channels.

Signal levels may be measured by using a broad band voltmeter if all signals except the one being measured are disabled. Alternatively a selective device may be used which will respond to the desired signal alone. The use of individually tuned filters, one for each measurement frequency, is possible; but becomes impractical when a large number of channels are involved. The use of a single filter which is continuously tunable over the entire base band spectrum is a more practical approach.

The required instrument is basically a superheterodyne receiver. However, to qualify as a measuring instrument, careful attention must be paid to such factors as stability, accuracy of amplitude and frequency calibration, and freedom from spurious signals inherent in heterodyne devices. Its selectivity must be adequate to resolve closely spaced signals. Input impedance should be high to minimize loading effects while making bridging measurements. Other desirable features include portability, self-contained calibration and means for aural monitoring of AM, FM, and SSB voice channels.

The need for a selective voltmeter, which would respond to only one of a number of signals channels present in a frequency division multiplex circuit, became apparent to Railway Communications, Inc.,* engineers during the design and development of multiplex equipment. The inability of available commercial instruments to meet requirements of selectivity, spectrum coverage and other features considered desirable, led to a prototype design for in-plant use. Success of the design has been followed by a number of succeeding models to extend spectrum coverage, culminating in the latest, designated Rycom model 2174 Frequency-Selective Voltmeter (Fig. 1).

The instrument circuit (Fig. 2) uses a single heterodyne with tunable oscillator and intermediate frequencies above the signal band to eliminate image responses. To minimize overload effects all attenuation is introduced at the input which allows the input stage and modulator to operate at the lowest possible level. Crystal filters are used except for the widest of the three IF bands (Fig. 3). The inclusion of the 3 kc band and demodulation oscillator for upper and lower side-band is primarily for the purpose of aural monitoring of single-side-band voice circuits. It is also valuable in surveying a proposed base band circuit to determine the noise existing in 3 kc bandwidths throughout the spectrum. FM transmissions are monitored by slope detection on one side of the 10 kc selectivity curve.

The narrow band filter will resolve individual tone channels spaced 170 cps apart. While finer resolution could easily be accomplished, tuning would become more difficult. A low-pass filter in the input suppresses interfering signals above the instrument's range and a high-impedance broad-band transformer permits measurements on balanced lines without recourse to external transformers. The balanced demodulator prevents heterodyne oscillator feed-through to the IF and extends the low frequency end of the range to below 1 kc. Although amplitude gradually falls for frequencies below 1 kc, measurement may be made down to approximately 400 cps with correction.

For more information on the Voltmeter circle **106** on inquiry card.

*Railway Communications, Inc., Raytown 33, Mo.

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Ablation Meter Measures Nose Cone Wear

Erosion of materials in inaccessible and high-temperature locations, including missile nose cones re-entering the earth's atmosphere, is measured by a new Ablation Meter using radio-isotope tracer techniques. The same equipment can be used in many commercial and industrial applications, such as measuring the erosion of the walls of a blast furnace while it is in operation. The unit, consisting of a sodium iodide crystal scintillation probe (Fig. 1), and a count rate meter (Fig. 2), is designed to work into telemetry equipment, tape recorders or local meter-type indicators.

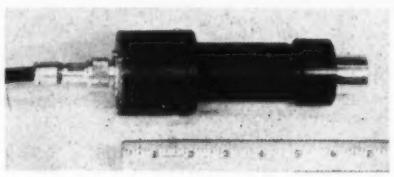

FIG. 1. SODIUM IODIDE crystal scintillation probe drives meter to output of 5v when used 7" from 0.4 m-curie of Cobalt 60.

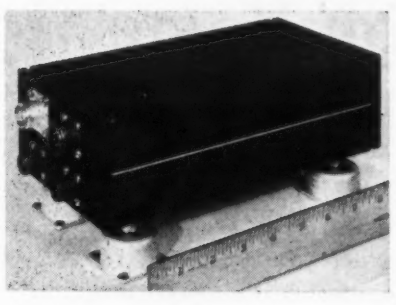

FIG. 2. COUNT RATE METER provides a dc signal output for telemetry system.

In use, the sides of a plug of the nose cone material are coated with a gamma-emitting isotope. The plug is then inserted into a mating hole in the nose cone. Enough tracer material is used to initially give a full scale reading on the instrument. As the nose-cone material wears away, the tracer material is proportionally reduced in amount, lowering the meter indication. For missile use, a long half-life isotope, such as Cobalt 60, is preferred. For test stand and furnace applications, Sodium 24, having a short half-life, prevents significant cumulative radiological contamination.

The meter uses 1.5 amperes from a 28 v dc source, but is also available in other standard ac and dc voltages. Its output is a dc signal adjustable in amplitude from zero to 5v and is linear over this range for counting rates to over 10,000 counts per second. Output impedance is sufficiently low to drive loads of 100,000 ohms. The meter is designed to withstand shocks of 40 G and vibration of 2,000 cps at 10 G.

The Ablation Meter, with auxiliary power supplies and test equipment, is a development of the Cook Research Laboratories, and is being manufactured by the Electronic Systems Division of the Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

For more information on the Ablation Meter circle **107** on inquiry card.

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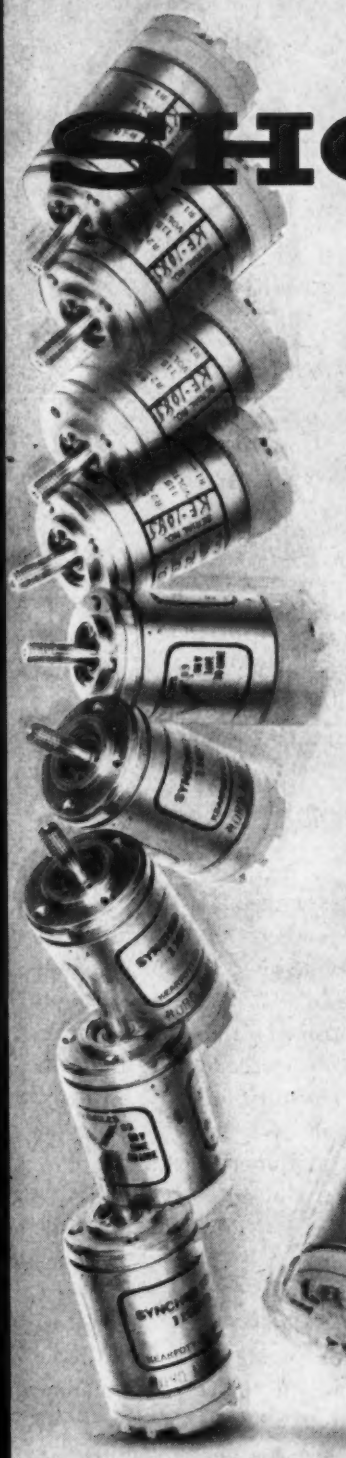

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For more information circle **16** on inquiry card.

FIG. 1. SUPER-DRY NITROGEN supply to Infrared Guidance System is ensured by miniature 26-oz Missile Dryer.

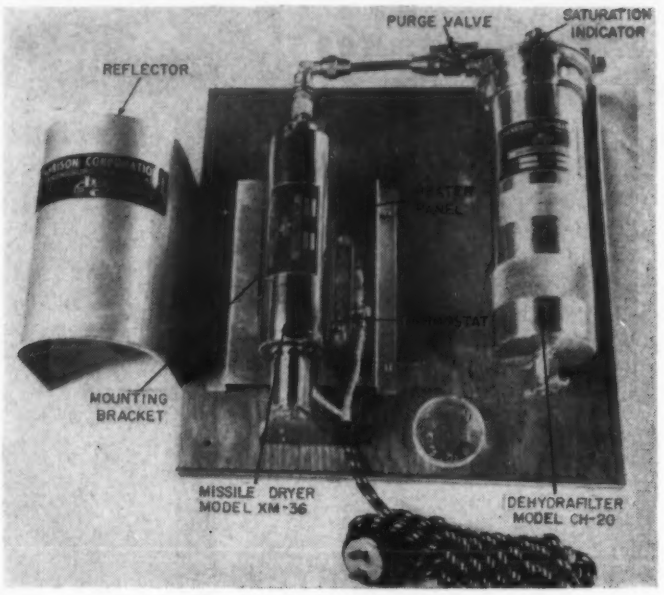

FIG. 2. MISSILE DRYERS exhausted in ground tests and prior to operational flights have drying power restored by reactivation in series with Dehydrafilter. Dehydrafilter cartridge can be replaced after reactivating 12 Missile Dryers.

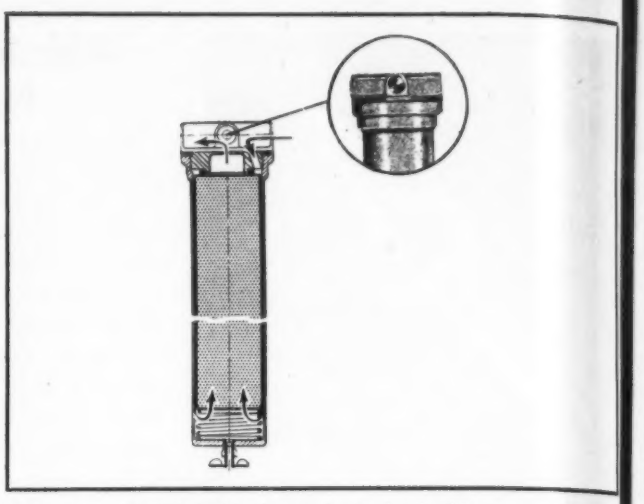

FIG. 3. AIR FLOW through Dehydrafilter cartridge is shown by arrow. Saturation indicator, enlarged in circle, changes from blue to pink when cartridge is expended.

Cure for Missile Thrombosis

SENSITIVITY of the infrared detector cell in certain missile guidance systems depends on the maintainance of cryogenic temperature throughout its flight. In one typical missile, temperature of —320°F is maintained by the expansion of nitrogen from pressure greater than 1000 psig to one atmosphere. At such temperature, the slightest trace of moisture, oil or particulate contaminant in the gas will clog the minute cryostat orifices. Because this malfunction resembles the clinical condition in which a clot clogs a blood vessel supplying a vital brain center, the trouble might be termed "missile thrombosis."

To meet the nitrogen dehydrating and filtering requirements of this missile, now being developed by the Missile Systems Division of the Raytheon Manufacturing Co., Waltham, Mass., a lightweight dehydrator-filter, designated the model XM-36 Missile Dryer (Fig. 1), has been developed. Because numbers of Missile Dryers must be used during development and ground testing, also because logistics of operational missiles demand a dryer which can be maintained ready for use, a system for reactivating the dryer is also required. Both the Missile Dryer and its reactivator (Fig 2) are new developments of Hankison Corporation, Canonsburg, Pa., originators of the Condensifilter and other pneumatic products for military and industrial use.

Although "dry" nitrogen is always specified for use in cryogenic systems, microscopic amounts of moisture and oil adsorbed in the pores of the metal of empty bottles may be released in the subsequent pressure cycle to contaminate the nitrogen. In the cryogenic system, nitrogen still under pressure passes through the Missile Dryer, where all such contaminants are trapped.

The drying action of the Missile Dryer is effective until it has adsorbed over 200 grains of water. It then can be removed from the missile and reactivated until a dewpoint equivalent to 0.00004 gr/cuft is achieved. In the reactivation operation air from a shop or ship-borne compressed-air system at about 40 lbs is passed into the Model CH-20 Dehydrafilter, a standard Hankison Corp. production item (Fig. 3). In Dehydrafilter, the air passes through a special filter pad to remove any particulate contamination, through ports down to the bottom of the filter cartridge, then up through the desiccant, past the saturation indicator crystals and out through the purge valve to the Missile Dryer, which has been removed from the missile and mounted on the heater plate of the reactivator. Electric heat, thermostatically-controlled to approximately 340°F, speeds the vapor separation. Construction details of the Missile Dryer, specifically tailored for the requirements of the missile under development, other than its design for test pressure of 6000 psig, are not divulged.

The Dehydrafilter cartridge, which has the capacity to reactivate at least twelve Missile Dryers, is filled with various grades of Molecular Sieves, a desiccant type produced by Linde Div., of Union Carbide Corporation. As a dessicant, this material is more effective than other commercially available materials; also it can be exactly formulated for selective adsorption of oils and other hydrocarbons as well as moisture. (In *adsorption* moisture and oils adhere to the surfaces of the adsorbing material without causing an accompanying physical change, as for example, sugar crystals which *absorb* moisture change to liquid syrup.)

The process of reactivation uses the drying effect of expansion in combination with the phenomenon of adsorption. For example, saturated air at 70°F room temperature and three atmospheres pressure is dried while passing through the Dehydrafilter to a dewpoint of —90°F, still at a pressure of three atmospheres. In expanding to 1 atmosphere before it enters the heated Missile Dryer, it is calculated that the dewpoint drops to approximately —110°F. The combined effect of heat and dry air further depresses the moisture content of the Missile Dryer to about 0.00004 grains/cuft. This value is calculated because the best commercially available dewpoint recorders can measure only to about 0.0006 gr/cuft.

When the saturation indicator of the Dehydrafilter changes color from blue to pink showing that the cartridge has been exhausted, the case of the Dehydrafilter can be removed without disturbing its connection to the air pressure system or to the Missile Dryer, the expended cartridge removed, and a fresh cartridge

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inserted. Dry air passing through the indicator quickly restores its blue (dry) color.

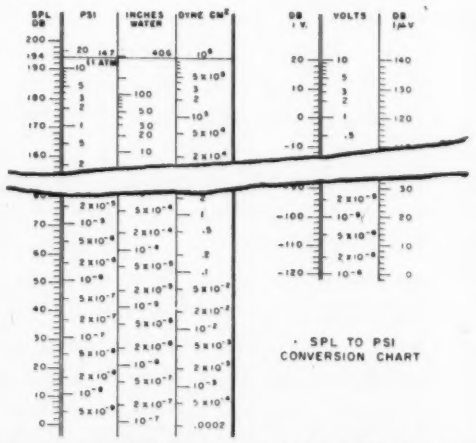
Besides the cryogenic application for nitrogen drying, filters are indicated for reliability wherever pneumatic missile controls or pneumatic ground support systems are used. According to recent reports, this encompasses twenty-two Army, Navy and Air Force missile systems now operational or under development. Each system may have a different problem in preventing pneumatic failures in which the application of specialized knowledge and experience is indicated.

The Condensifilter, another dehydrator built by Hankison, has been adopted for use in atomic ships now building. This filter and dehumidifier depresses the dewpoint of air within 2°F of the temperature of the coolant supplied to it; is made in capacities to 100 SCFM in single units, and to 500 SCFM in manifold installations. Questions on specific filtering and dehydrating problems for liquids as well as gases will be welcomed by the Hankison Corporation.

For more information on Dehydrafilters circle **108** on inquiry card.
For more information on Condensifilters circle **109** on inquiry card.

Sound Pressure Level Pickup

Destructive levels of high-intensity noise can now be measured by the CEC Type 4-340 sound pressure level transducer. Operating on the electrokinetic principle, the 4-340 utilizes electrical signals generated by a minute flow of polar fluid passing through a microporous ceramic disc. When the direction of flow is reversed, polarity of the generated voltage is also reversed.



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Frequency variations have little effect on output, the instrument's response being flat within ±3 db from 3 to 25,000 cps. As a precision instrument, the 4-340 will measure the high intensity sound generated in acoustic-test chambers to determine sound pressure levels harmful to tubes, printed wiring boards, and similar equipment. It can also serve as an alarm trigger to protect personnel who may be seriously injured by exposure to high intensity sound. (Sound pressure levels can be translated to psi, inches of water, and dynes/cm² by the conversion table given). (*From technical bulletin* 1573*A*, *Consolidated Electrodynamics Corp.*, 300 *N. Sierra Madre Villa, Pasadena, Calif.*)

For more information on the Transducer circle **110** on inquiry card.

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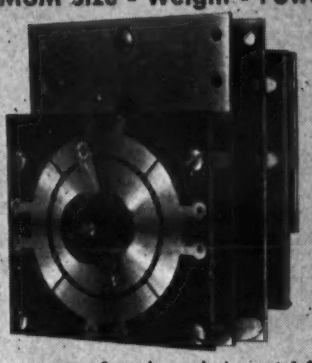

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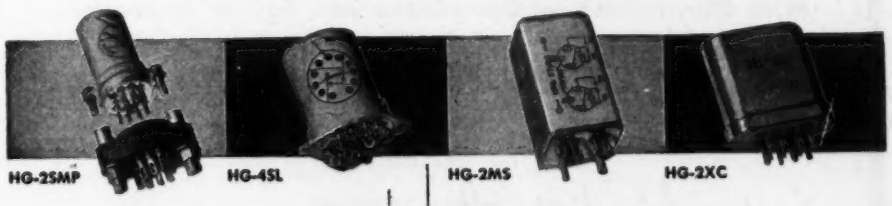

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Missile Solenoid Valve Is Se

MISSILE fuel and hydraulic systems are controlled electrically through solenoid valves. High reliability, light weight and low internal pressure drop are important design criteria for these key components.

The unique Valcor solenoid valve, (Fig. 1) designed particularly for missile and aircraft applications, uses a simple straight-line flow pattern which interposes a minimum resistance to fluid flow when open. Other notable features of this valve are the self-cleaning floating seal and its high-temperature glass-varnish-impregnated solenoid coil.

The valve mechanism consists of three basic parts—the plunger, the disc, and the valve seats (Fig. 2) positioned in a housing. All wearing parts are removable and easily replaced. The actuating mechanism is completely independent of the valve body itself.

The plunger is flattened at the end and has a hole in it which retains the sealing element, an optically flat carbon disc which has been fired above 3000°F and is impervious to most acids and alkalies. This disc is free-floating and is held against the valve seat by the pressure of the fluid when in closed position. Both seats and the sealing disc are flat, so that the valve seals equally well on forward and back pressure—in fact, the valve may be installed without regard for direction of flow. As the Valcor valve is cycled, the face of the seat is always wiped clean as the disc and plunger move up and down.

The maker claims that extensive tests with sand, filings, lint and dirt have proved that the free wiping action between the disc and the seat (Floating Seal) prevents interference by contaminants with the normal operation of the valve. In many applications wear on the disc is said to be almost imperceptible after 2 million valve operations, and the valve to still operate perfectly. Fuel valves operate under maximum pressures to 800 psig; hydraulic system valves up to 3,000 psig.

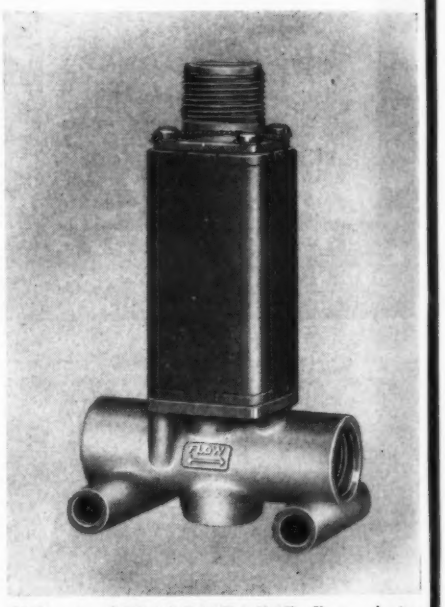

FIG. 1. STRAIGHT-LINE flow design of new military fuel and hydraulic valve permits maximum flow, minimizes size and weight in missile and aircraft use.

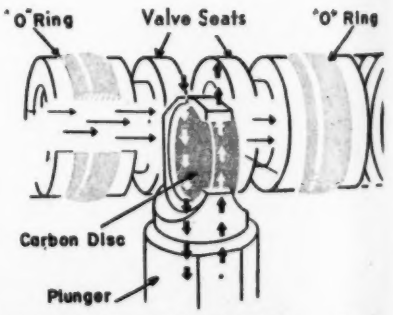

FIG. 2. SELF-CLEANING, optically-flat carbon disc is said to hold its seal equally for forward and back pressures over millions of operating cycles.

FIG. 3. SURE Valcor valves with do and 3/8"

Is Self-Cleaning

Straight-through design imposes minimum resistance to fluids when the valve is open. Fig. 3 shows flow pressure curves for various Valcor Valve sizes. Lines for equal lengths of standard tubing sizes are included for comparison. Conventional valve designs require a larger cross-section, usually at greater cost, to deliver the same flow.

The Valcor solenoid coil is wound "wet", with silicon, Teflon or glass-insulated wire saturated with impregnating silicone varnish, in contrast with the conventional practice in which a dry-wound coil is immersed in varnish. Even under vacuum and pressure cycles, varnish frequently fails to penetrate all voids in dry-wound coils, leaving spaces susceptible to moisture and having unpredictable heat-transfer characteristics. The Valcor solenoid, when baked, becomes a solid copper-and-glass structure with coil and leads rigid in the housing which is impervious to moisture, mildew, salt spray and fungus.

The Valcor solenoid valve meets all applicable Military specifications and has been tested for operation to 1000°F and at accelerations of 50 G. With over a half-million units now in missile and military aircraft applications, it has recently been made available for other high-performance valve uses by its maker, the *Valcor Engineering Corp.*, 5365 *Carnegie Ave., Kenilworth, N. J.*

For more information on Valcor Solenoid Coil circle **111** on inquiry card.

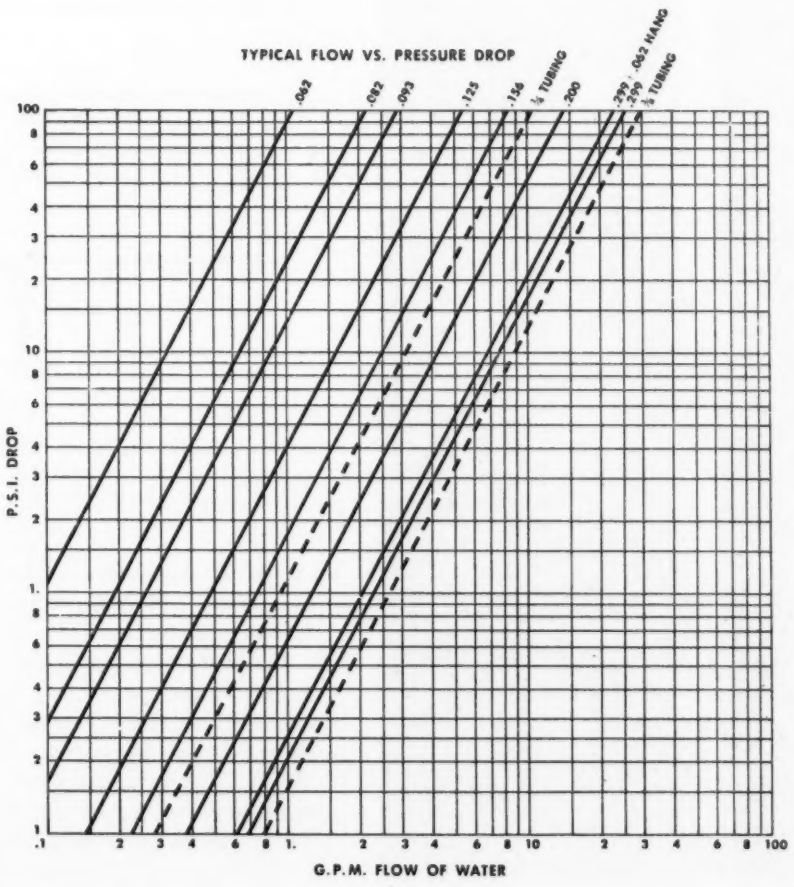

FIG. 3. FLOW VS PRESSURE data graphs for Valcor military solenoid valves are compared with dotted lines for 1/4" and 3/8" tubing.

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Max/Min Torque (in. oz.)	1.5/.3	1.5/.3	3.5/.3
Bits per shaft revolution	40	40	40
Weight (incl. cables)	4.7 oz.	4.8 oz.	8 oz.
Case Length	2⅜ in.	2⅜ in.	2⅜ in.
Mounting Pilot	1.754" dia.	1.754" dia.	2.156" dia.

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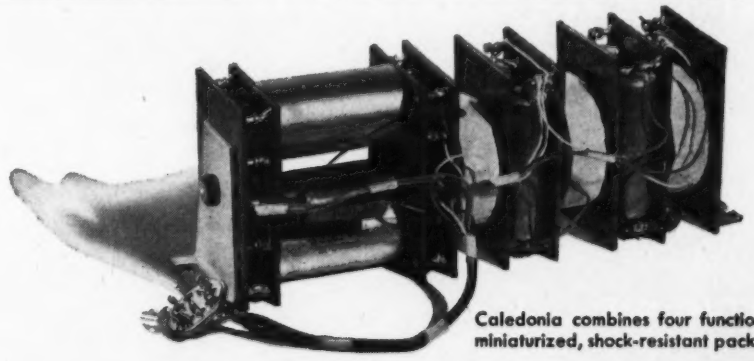
For more information circle **23** on inquiry card.



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For more information circle **24** on inquiry card.

New Total Temperature Probes Provide Many Essential Measurements

Total temperature probes, which detect the static air temperature plus the temperature rise caused by high speed air flow, are sensing instruments used on operational missiles and aircraft to determine true air speed, air density, to detect jet streams, and to assist in true altitude computation.

The new 101G probe (Fig. 1) is a high precision sensing element utilizing individually calibrated adjustments guaranteed to meet a master calibration curve within 0.1°C in the range from —150°C to 150°C. The probe can also be supplied for operation up to 350°C, and with modifications to 650°C with proportionate reproducibility.

The probe normally is fitted to extend 3″ beyond the skin of the aircraft or missile. This is for positioning the head of the probe outside the boundary layer air, which is essential for accurate total temperature readings. Within the boundary layer heat may be added to or removed from the static air temperature, whereas outside the boundary layer the air flow is adiabatic (that is, no heat addition or removal). Adiabatic flow up to the probe entrance is a requirement for accurate performance. Especially thin or unusually thick boundary layers might dictate a change in the 3″ extension length.

The sensing element construction is shown in Fig. 2. A 2-mil platinum wire, protected by refractory cement, is encased in a platinum housing to minimize thermal stress in the sensing wire which would result in consequent modified calibration and hysteresis effects. The platinum element housing is hermetically sealed with gold solder to prevent damage to insulation resistance by humidity. A gold-platinum alloy radiation shield surrounds the element tube, and the whole is further shielded by a stainless steel external radiation shield (Fig. 3).

The performance of the 101G probe has been thoroughly measured from subsonic speeds through Mach 4.

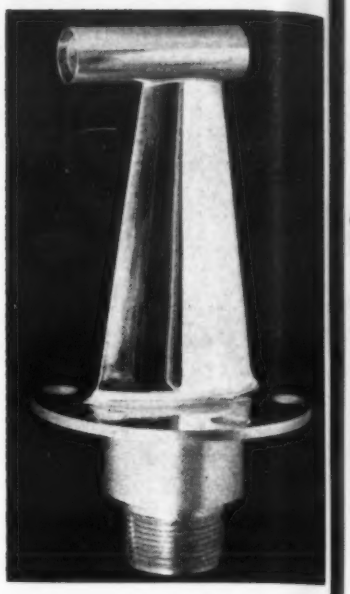

FIG. 1 PLATINUM TUBING and wire sealed with gold solder go into construction of temperature sensing element.

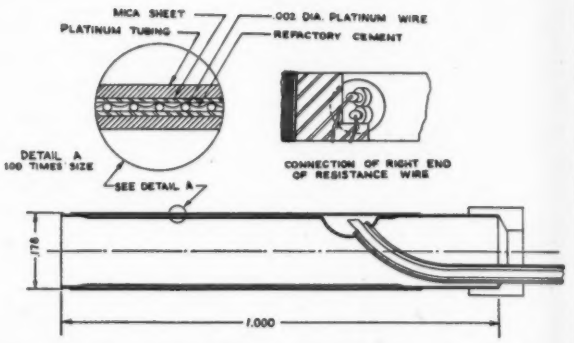

FIG. 2. LONGITUDINAL SECTION of probe head.

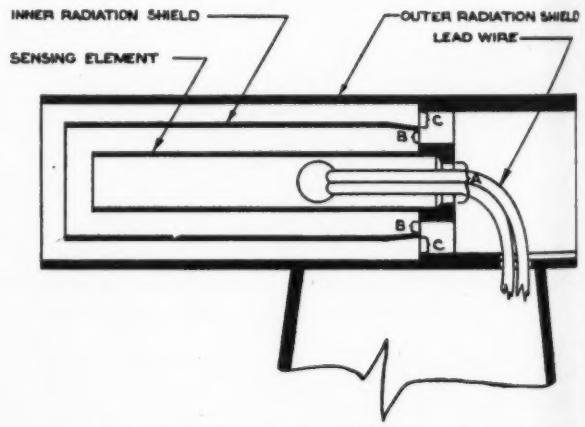

FIG. 3. THREE-INCH EXTENSION holds total temperature probe element outside the boundary layer to minimize errors from air friction. Model 101G is shown.

Time constants, radiation error, recovery error and angle of attack sensitivity curves are available from the manufacturer.

Installation of the probe is simple due to its small angle-of-attack sensitivity. A good location is the fore end of the fuselage. If supplied with de-icing heater, the probe is designated 101GD. Both models meet Mil-P-25726A requirements. The 101 Series probes are a development of the Rosemount Engineering Co., 9424 Lyndale Ave. So., Minneapolis 20, Minn.

For more information on the Probe circle **112** on inquiry card.

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Input Power (total) 3.8 watts Stall Torque .15 oz in min. .20 oz in nom. Max. Weight 29 gms.	Input Power (total) 5.6 watts Stall Torque .3 oz in min. No Load Speed 6500 rpm min.	Generator: Input Voltage 10 v Output Voltage 0.13 v /1000 rpm max.	Output Power 4.0 watts No Load Speed 20,000 rpm Input Voltage 28 v DC	Linearity .5% Null E at EZ .015 v Phase Shift 15 deg. lead	Accuracy 7′ error max. Null 30 mv max. Phase Shift 8.5 deg. lead	Accuracy 30′ max. error spread Torque Gradient 2200 mg-mm/deg. Input Power .54 watts	Accuracy 7′ error max. Null 30 mv max. Phase Shift 8.5 deg. lead	Accuracy 7′ error max. Null 30 mv max. Phase Shift 9 deg. lead	Accuracy 7′ error max. Null 30 mv max. Phase Shift 11 deg. lead

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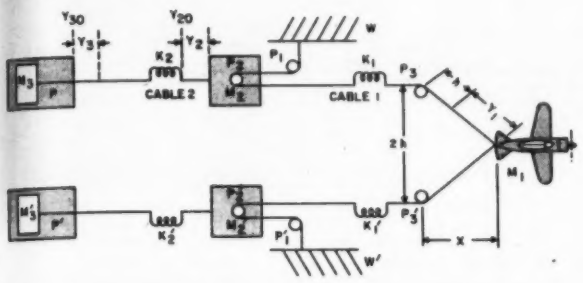
Clifton Heights Pennsylvania

For more information circle **25** on inquiry card.

Dynamic Analysis of an Aircraft Arresting Gear System

In the design of an aircraft arresting gear system, cable tension specifications are important parameters in determining the maximum landing loads and velocities a particular system can safely handle. Cable performance may be described in terms of the following specifications:



i) Maximum rated cable tension; that value of cable tension which will either cause the cable to snap or to be permanently deformed, i.e., exceed its elastic limit. ii) Working limit cable tension; this is generally defined as one-half the value of the maximum rated cable tension. Pragmatically it is that value of cable tenison such that if cable tension is constrained below this value, the cable lifetime will be essentially indefinite.

The essence of the simulation study becomes twofold; (a) to determine the system response over a range of aircraft landing speeds and loads; and (b) to determine those combinations of aircraft landing speeds and weights which would result in cable tension exceeding the working limit cable tension.—(*From 8-page application Bulletin No. 6, same title, Electronic Associates, Inc., Long Branch, N. J.*)

For this literature circle **113** on inquiry card.

About Drop-outs

No two tape manufacturers measure or specify dropouts in the same way. While this makes it easy to produce a perfect tape . . . by simply tailoring the dropout counting technique to the tape . . . Soundcraft engineers prefer to run drop-out tests under what we consider very rigid conditions:

First, we pack 200 pulses per channel per inch, with multi-channel heads that are each 24 mils wide.

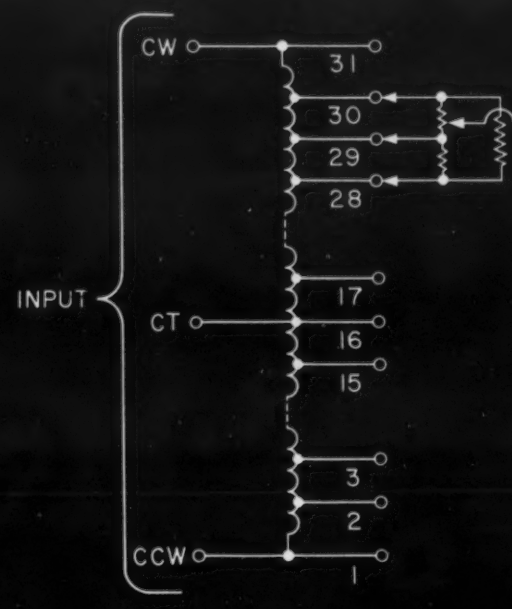
Second, we write and read pulses 10 μsec wide, and on reading back, if we fail to measure 50% of the signal written, it is considered a dropout.

On tapes having a 1.0 mil base we set 400 drop-outs per 100,000,000 pulses recorded as our quality control limit.

On tapes having a 1.5 mil base the limit is set at 600 dropouts per 100,000,000 pulses recorded.—(*From 12-page technical brochure on Type A Instrumentation Tape for Digital Recording, Reeves Soundcraft Corp., 10 E. 52 St., New York 22, N. Y.*)

For this literature circle **114** on inquiry card.

with this unique principle...



In the Vernistat a-c potentiometer, a tapped autotransformer divides input voltage into 30 levels, which are interpolated by a one-turn potentiometer. By means of a unique switching method, 10 shaft turns connect potentiometer taps and autotransformer taps in synchronism with the wiper mechanism. Result: smoothly varied output over the entire voltage range.

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Reduces system complexity and cost. With this one compact device, you can eliminate isolation amplifiers, shielded cables, summing resistors with resultant signal loss, and separate transformers with accurate center taps. Quadrature rejectors, as well as other phase-compensation schemes, are generally unnecessary.

Increases system reliability and accuracy. With fewer system elements, system reliability goes up. High linearity, an inherent Vernistat feature, is maintained over its entire life. Low phase shift, another plus, helps attain accuracy.

Permits greater design freedom. The Vernistat is easily modified to provide similar basic features in nonlinear functions with excellent conformity. Unlike helical-type units, it can be continuously rotated because of its planetary principle. A wide selection of models is available which meet military specifications.

• • •

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NEWEST ADDITION to the Vernistat line is a miniaturized a-c potentiometer (synchro size 11). See brochure for specifications.

For more information circle **26** on inquiry card.

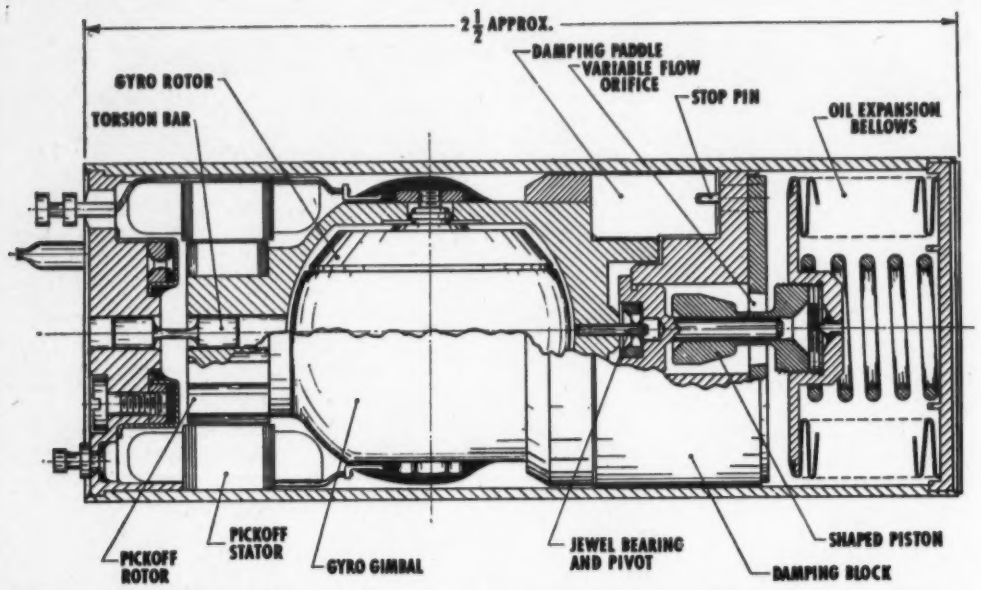

FIG. 1. VARIABLE-FLOW orifice actuated by oil expansion bellows provides accurate compensation for viscosity variation in new RGB Rate Gyro.

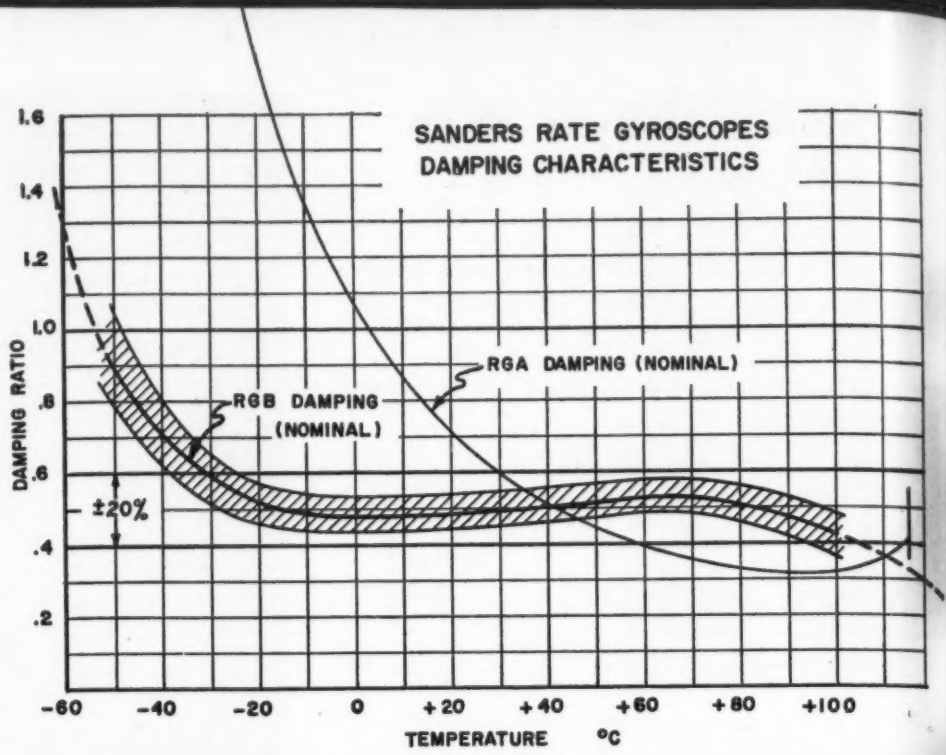

FIG. 2. VARIATIONS IN damping ratio are held close to nominal value over a wide temperature range by RGB damping system. Earlier RGA damping characteristic is shown for comparison.

Temperature-Controlled Rate Gyro Damping

The rate gyro—an important component of control and stabilizing systems in missiles, supersonic jet planes, and inertial guidance systems—has achieved a high level of accuracy and sensitivity by the use of the "floating" technique. Methods for reducing changes in the damping rate of a floated rate gyro which result from ambient temperature variations are here discussed.

Kenneth E. Mayo

Project Engineer—Sanders Associates, Inc.

INDUCED EDDY CURRENTS, viscous shear and dashpot damping are but a few of the available general methods of damping dynamic mechanical systems. The adaptations and applications of these and other methods represent a variety of techniques. The use of liquid fluids for viscous shear and dashpot damping is most common in the field of electro-mechanical instrumentation.

Damping force is proportional in magnitude and opposite in direction to velocity. It is similar in nature to acceleration force, which is proportional to mass and acceleration and opposite in direction. Because the required damping force is a function of the dynamic mass of the system, relatively large damping forces are often required in small instrument packages such as a subminiature rate gyroscopes. By utilizing a relatively incompressible fluid of a known viscosity, high damping forces can be developed in a very small volume. The fluid offers buoyancy to reduce bearing loads when gimbal bearings are used and to increase the resistance of the instrument to "G" loads.

For a number of years, research, directed toward developing fluids with high density and appropriate viscosity characteristics for damping applications, has been in progress. To date, the damping fluids most used are exemplified by the Dow-Corning DC-200 series of silicone oils. These fluids have room temperature viscosities ranging from below 0.5 centistokes to above 200,000 centistokes. Over the temperature range of —35°C to 90°C they can vary in viscosity by nearly 14 to 1. While this is a relatively constant viscosity-temperature characteristic compared with oils not specially adapted to damping, there are many applications where a 14 to 1 variation in damping cannot be tolerated.

In an attempt to minimize the effect of viscosity variations on damping, many instruments have been designed and built with thermostatically controlled heaters. This technique has several drawbacks. Subminiature thermostats have not been as reliable as the instruments they are protecting and thus can introduce a weak link in a very expensive piece of equipment. Heaters invariably increase the average operating temperature of the instrument and thus shorten its life. Heaters also use large quantities of costly power, an important consideration in missiles where space and weight are at a premium. Consequently, new techniques have been sought for achieving constant damping regardless of temperature variation.

Viscous Shear Compensation

Viscous shear damping was employed in Model RGA subminiature rate gyro. The damping force, B, is developed as a rotating cylinder expands, causing the shearing action of the fluid to increase between cylinder and gyro case. From the formula

$$B = 2 \pi v^3 l \mu / h$$

where v = damping cylinder radius, l = damping cylinder length, h = shear gap, μ = viscosity of damping fluid.

It can be seen that a change in damping cylinder radius or damping gap caused by expansion of the damping cylinder with temperature can be used to

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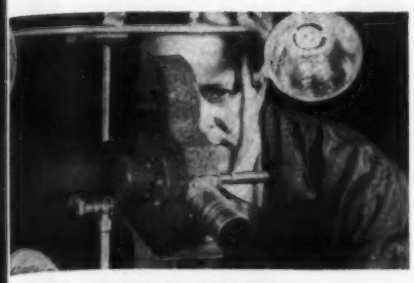
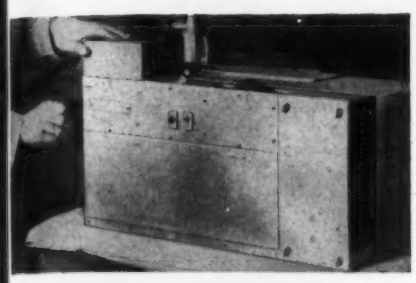


SHOOT



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compensate for viscosity variations. In the Model RGA gyro this technique achieved adequate compensation over a short temperature range which was increased by the use of heaters when the requirements were more stringent.

Laminar Flow Compensation

Recent advances in missile technology, together with associated refinements of guidance and stabilization systems, more stringent requirements on power and weight, and ever-broadening temperature requirements, have all increased the importance of achieving adequate damping compensation without using heaters. This led to the development of the Model RGB rate gyro, designed to increase the operating temperature range over which a constant damping force is maintained. It employs a form of dashpot damping. As the gyro precesses, paddles, attached to the gimbal, pump damping fluid through flow-restricting passages. Appropriate choices for dimensions and fluid viscosity assure laminar flow throughout the operating range of the gyro. The resistance to flow can then be described by the following laminar flow equation:

$$\Delta P = 4\ Q\ l\mu /\ K\ W\ C^3$$

where ΔP = pressure difference across paddles, Q = displaced volume of fluid, l = length of flow path in flow restricting areas, μ = fluid viscosity, W = width of rectangular flow path, C = clearance in rectangular flow path, and K = empirical constant relating proportionality of W and C.

In the RGB gyro, as in the RGA, an evacuated bellows is used to compensate for fluid volume changes with temperature variation. In the RGB gyro, this bellows is used also as a mechanical thermometer to position a shaped piston as a function of temperature. The piston is used to vary the pressure drop across the variable orifice in accordance with the formula above. The profile of the piston is contoured to approximately correspond to the variation of damping fluid viscosity as temperature and piston position vary (Fig. 1). This device, in keeping with other features of the gyro, is unusually accurate.

In the RGB the nominal damping characteristic is held to less than ±20% variation from the set valve over a temperature range of −30°C to 100°C (Fig. 2). Adjustments can be made to control damping within ±10 per cent of set value from −30°C to +90°C and not to exceed twice the set value at −55°C This is done while using a damping fluid that has a viscosity variation in excess of 25 to 1 over the temperature range, but which solidifies in the region of −65°C.

The RGB rate gyro can be cooled below the freezing point of the damping fluid without damage, but will not deliver an accurate rate signal while frozen. The motor, however, will operate and deliver about 3 watts of power to its surroundings and thus tend to thaw itself out at ambient temperatures below the freezing point of the damping fluid.

For more information on this feature circle **115** on inquiry card.

MODERN TESTING METHODS Assure Product Reliability and Quality for Jefferson Electronic

DIT-MCO Circuit Analyzers Automatically Detect Finite Flaws in Highly Complex, Multiple Interconnected Circuitry

A simple, efficient system for planning, performing, controlling and recording the complete test cycle of any electronic or electrical circuitry has been developed by DIT-MCO, Inc., Kansas City, Missouri. This revolutionary concept can virtually eliminate electrical circuitry errors, both in assembly line and custom manufacturing operations. In action at the Jefferson Electronic Products Corporation, of Santa Barbara, California, it provides the exacting quality control and reliability which have helped to make the company's products famous. In addition to quality control and universal application, the system improves interdepartmental communications, facilitates coordination and provides up-to-the-minute test information at any stage of planning, production or maintenance.

This new testing system is built around the DIT-MCO Circuit Analyzer, a highly accurate, automatic circuit tester which makes rapid, sequential tests of any complex, multiple interconnected circuitry. The basic model tests up to 200 circuits in twenty seconds, and test capacity can be enlarged to any required degree by adding multiplier sections. It detects potentially dangerous, finite wiring flaws by simultaneously testing one wire against all others commoned together . . . without special connections. All external resistive devices are automatically energized and functionally tested, and circuits connected together at common terminal points are thoroughly checked. The Analyzer never requires internal modification and easily adapts to any test by use of adapter cables. The exclusive DIT-MCO Matrix Chart pinpoints error location, circuit number, type and amount of fault, enabling technicians to make corrections without reference to manuals or diagrams. Standard, telephone-type components give years of trouble-free service with minimum maintenance. Nontechnical personnel easily master operation with less than one-half hour's instruction.

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For more information circle **28** on inquiry card.

High-Altitude Generator Eliminates Brushes

W. J. Shilling, Aircraft Equipment Eng. Div., Westinghouse Electric Corporation

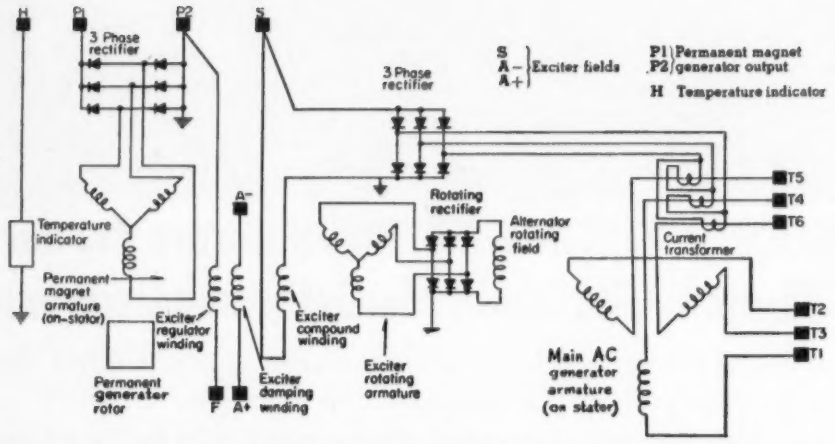

FIG. 1. BRUSHLESS AIRCRAFT GENERATOR (40-kva, 400-cycle synchronous) with permanent-magnet pilot generator. Schematic diagram.

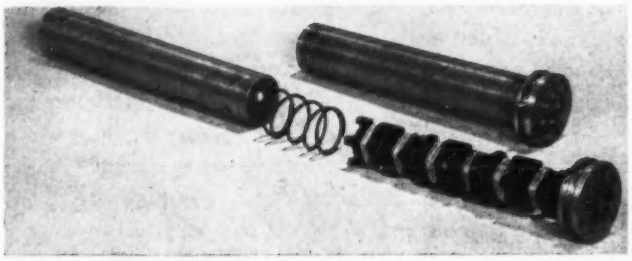

FIG. 2. OIL-COOLED SILICON rotating rectifier unit.

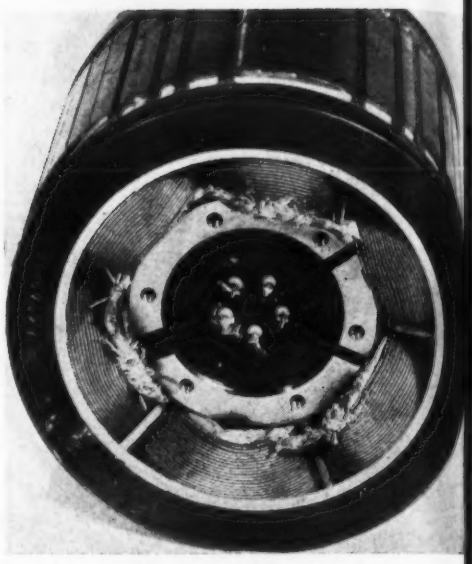

FIG. 3. ROTATING RECTIFIER assembled in the hollow shaft of the generator field.

AIRCRAFT generators in some new high-performance planes are required to operate at ambient temperatures of 300°F and above, and to altitudes of 65,000′ and above. In this environment brush life presents an almost insurmountable problem to the generator designer.

Westinghouse engineers solved the problem by a direct and novel approach—they eliminated all the brushes. The new design is still basically an ac 400-cycle synchronous generator having the inherent advantages of the synchronous generator: Light weight, high efficiency, good voltage wave form, and quick response to aid regulation. The dc excitation, however, is provided to the generator's rotating field from a three-phase ac exciter by using a three-phase bridge rectifier mounted directly on the rotor. Brushes aren't needed as no current flows between rotor and stator in any circuit. The only connection between rotor and stator is through the magnetic field.

In this brushless generator (Fig. 1), a regulator rectifies a small portion of the generator's three-phase output and applies the proper dc excitation to the exciter field (on the stator). The exciter is a small synchronous three-phase generator with its output on the rotor. This ac output is fed to a rectifier (also on the rotor) which in turn supplies dc power to the main generator rotating field. To start the system a separate dc power system may be used to "flash the field" of the exciter, a pilot exciter system using permanent magnets on the rotor may be added, or (Fig. 1) permanent magnet interpoles in the exciter may be furnished which make possible an automatic "flashing" system. Reversal of polarity cannot occur since excitation is obtained through silicon rectifiers and a Magamp* regulator.

Figure 2 shows an oil-cooled rotating rectifier assembly using silicon rectifier cells. This rectifier is mounted directly in the center of the hollow shaft (Fig. 3). The rectifier cells (six required per rectifier) are hermetically sealed silicon units which operate in oil at 300°F and supply excitation to a 40-kva generator. This unit, the Westinghouse Model 6QM40B oil-cooled synchronous generator, is illustrated in Fig. 4 with its constant-speed drive unit. Oil-cooling can be used when ram temperature makes the use of air-cooled generators impractical. The brushless design is particularly suitable for oil-cooled generators as it has no brushes, rings or commutators which might be fouled by oil-leaks. The silicon rectifiers are also efficiently cooled by the oil stream.

New miniature heavy-duty silicon rectifiers provide several advantages over brushes: The generator (1) is insensitive to altitude and atmospheric conditions, (2) is capable of operating in 300°F ambients, (3) has low radio noise, (4) has no "commutation" problems, and (5) has long life. As to the latter item, the life of silicon cells is not known yet, but cells have run several thousand hours in laboratory tests without incurring a 100 percent increase over initial voltage drop (which is the usual definition of life). In comparison, aircraft brush life of more than 1000 hours in low-temperature, low-altitude (50,000′) applications is considered very good.

With still higher altitudes and ambient temperature requirements for generators seen on the horizon, more is expected from the brushless synchronous generator.

*Copyright Name, Westinghouse Electric Corp.

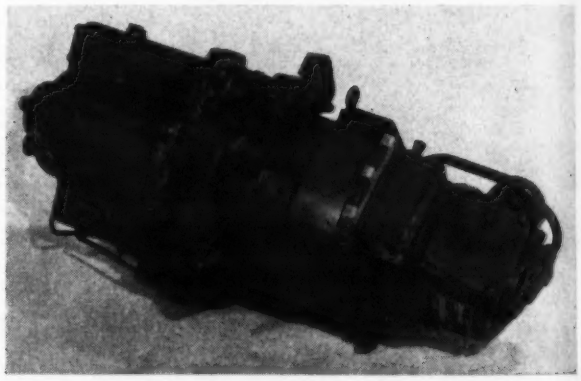

FIG. 4. 40-KVA BRUSHLESS AIRCRAFT GENERATOR and constant speed drive unit (generator is on the right).

For more information on the Generator circle **116** on inquiry card.

High-Accuracy Temperature Indicator/Re-transmitter for Jet, Missile Motors

FIG. 1. SERVO-DRIVEN null-balancing engine temperature indicator is a high-accuracy system complete in 3" by 7" case.

A NEW servo-driven, null balancing potentiometric indicator, designated the "BH183 Auto-Temp Unit," is said to provide jet engine turbine inlet (T.I.T.) and exhaust gas temperatures to laboratory accuracy (±0.085%) under severe service conditions. The miniature panel instrument (Fig. 1) measures gas temperatures through the emf output of a chromel-alumel thermocouple harness on the aircraft or missile engine. Completely enclosed in the cylindrical case is a 144" slide-wire null-balance potentiometer, zener-referenced power supply, transistorized amplifier, servo motor, cold-junction compensation, chopper, and linearized counter-type readout (Fig. 2).

Attained accuracy of ±1°C in the 500° to 1000°C range is attributed to the calibration method, in which the tape potentiometer, a 144" long resistance wire bonded to one edge of a mylar tape provides infinite resolution. The tape is perforated along the other edge and mounted on two spools as is motion picture film. By varying the distance between consecutive sprocket holes a few thousandths of an inch, a non-linear resistance to hole-count relation is accurately established during slidewire calibration.

The tape is transported between the two spools (Fig. 3) by means of a servo-powered sprocket wheel with tapered teeth. A digital indicator is geared to the sprocket wheel drive shaft for accurate readout. The tape, with its resistance wire and non-linear hole spacing, is in effect an accurate and basic analog-to-digital converter. A dial indicator for quick visual check of approximate values is geared to the sprocket wheel drive. Temperature changes can accurately be followed up to 150°C/sec. A red light "over-temperature" warning, preset at factory at any point up to 1200 °C, with press-to-test facility, and power-failure "off" flag are also provided.

At present used only as a temperature indicating device, provision is made in the unit design for the addition of a re-transmitting slide-wire as a linear input device for recording, computing or telemetering units when required. Also, only minor modifications would be required to adapt the potentiometer to inputs from strain gages, resistance units, tachometers, etc. The

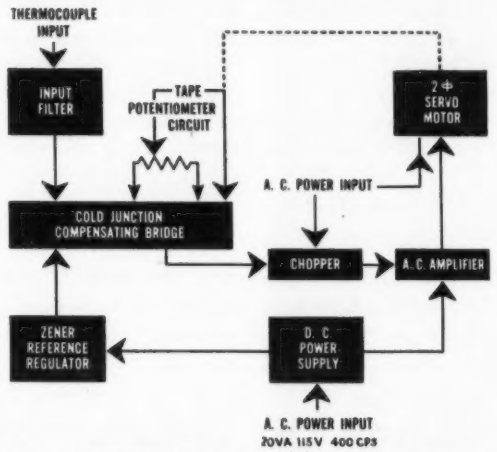

FIG. 2. ACCURACY to 1°C in the jet engine range is attained by power regulation, chopper-amplification and compensation plus novel calibration method.

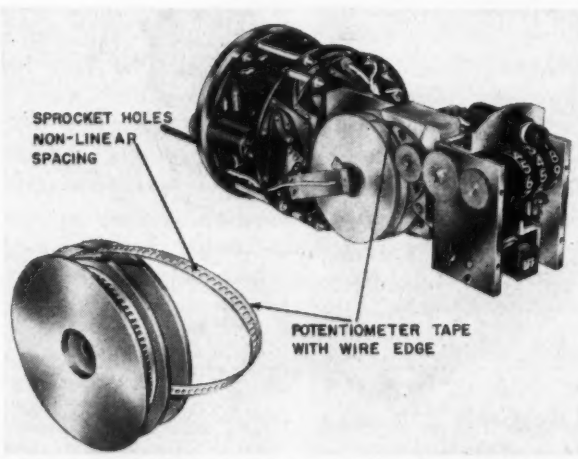

FIG. 3. CALIBRATION is achieved by non-linear spacing of sprocket holes in 12-ft tape bearing resistance wire in edge.

AutoTemp is hermetically sealed for operation to 85,000 ft. altitude, withstands vibration per MIL-E-5272, and suppresses radio noise to the limits of MIL-I-6181. Additional information on its characteristics is available on request from the manufacturer, *B & H Inst. Co., Inc., 3479 W. Vickery Blvd., Ft. Worth 7, Tex.*

For more information on the Auto Temp circle **117** on inquiry card.

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River Radar Guides Tows with Inch-Clearance Accuracy

Study of the characteristics of a close-range radar especially designed for navigation of river barge tows will be of particular interest to engineers and technicians familiar with standard marine radar. The new "Mariners Pathfinder," recently announced by the Raytheon Manufacturing Co., Waltham 54, Mass., is designed to increase the accuracy of all-weather navigation of large tows such as that shown in Fig. 1, common on our inland waterways.

Besides navigating by night and in fog, today's river pilots must also contend with low and narrow bridges, small locks and changing channels. Tankers and barges often navigate in very swift currents—and with only inches to spare. With river tows comprising 20 to 40 fully loaded barges linked in units 1300 ft. long accurate radar presentation is an acute need.

System characteristics which permit sharp definition at short ranges are: X-band frequency of 9330 to 9420 megacycles; peak power 40 kw; pulse length of 0.14μsec on ½, 1, 2 and 4 mile ranges at 1600 pps rep rate; pulse length of 0.6 μsec on 8, 20 and 40 mile ranges with 800 pps rep rate; antenna rotation 14 rpm; antenna pattern 15° vertical, 0.65° horizontal, at half power points.

FIG. 1. HUGE INTEGRATED TOWS and other river craft will benefit from Raytheon's new X-band radar. Pioneer of its class, the HARRY TRUMAN is shown on her maiden voyage a few years ago with a conventional radar antenna atop the wheelhouse. Eleven-foot slotted-waveguide antenna would occupy a similar position.

Short pulse-lengths, wide-band, low noise IF strips, and a fast-acting transmit-receive duplexing system enables the new "Mariners Pathfinder" to receive returns from close-in objects only 30 yards from the

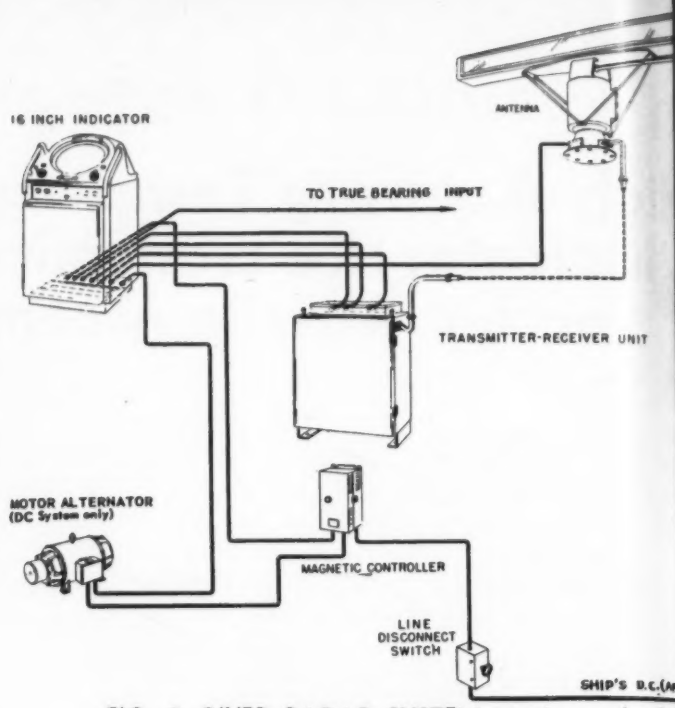


FIG. 2. RIVER RADAR SYSTEM requires only three major units. Motor alternator is needed only on d ships.

antenna. The new slotted-waveguide antenna desig eliminates back radiation and gives pinpoint definitio of small targets.

For more information on Mariners Pathfinder Radar circle **118** on inquiry card.

Printed Circuit Plating Specifications

A. Scope

1. This specification covers the requirements of electrodeposited coatings of tin-lead alloys on various basic metals.

2. Tin-lead electrodeposits are corrosion resistant and readily solderable.

B. Applicable Specifications

ASTM A-219 Methods of Test for Local Thickness of Electrodeposited Coatings.

C. Product Requirements

1. The tin-lead electrodeposit shall be smooth, adherent, uniform in appearance, and be free from such defects as blisters, pits, pores, unplated areas, and excessive edge buildup. Rack marks and rinsing stains shall be the minimum consistent with good workmanship.

2. The composition of the deposit shall be as specified on the applicable part drawing or factory work order. The composition shall be speciled as percentage of tin. The balance shall be lead. The tolerance on the tin content shall be $\pm 10\%$ of the specified content.

3. The minimum thickness of the tin-lead electrodeposit on all significant surfaces shall be as specified on the applicable drawing or factory work order. The significant surfaces shall be defined as those surfaces that can be touched with a sphere 0.75 inch in diameter, except for those surfaces on which a deposit of controlled thickness cannot normally be obtained, such as holes, recesses, and other interior areas.

4. The adhesion of the tin-lead electrodeposit shall be such that no evidence of poor adhesion is observed when the parts are subjected to the tests given in Section D. 5.

D. Inspection—Sampling: Submitted lots shall be random samples at a rate determined by Quality Control, MIL-STD-105A.

(*From new 20-page booklet, Military Standards for Printed Circuits, by Al Gross, Chief Engineer, Cleveland Metal Specialties Co., Cleveland, Ohio, for Ordnance Corps., Dept. of the Army. Covers applicable process, sampling, inspection and testing procedures in printed circuit construction. Price 75 cents, order direct from author*).

"Sandwich" Construction Extends Life For Data Tapes

Ten times the life of conventional instrumentation tapes is claimed for a new "sandwich" technique in the construction of computer magnetic tapes. A thin, low-friction, plastic layer is placed over the magnetic coating which prevents the oxide from contacting the recording head at any time (Fig. 1). This layer eliminates oxide rub-off, extends recording-head life and virtually eliminates drop-outs, according to the manufacturer, *Minnesota Mining and Mfg. Co.*, 900 *Bush Ave., Saint Paul 6, Minn.*

The plastic layer is sufficiently thin, only 50 microinches thick, for all instrumentation recording except those applications requiring extremely high frequency responses. Oxide rub-off, which occurs with all conventional tapes, gradually wears away the oxide laye and also deposits oxide on the recording head. Either condition can cause signal error in data recording while the same oxide wear in music or speech record ing would probably pass unnoticed.

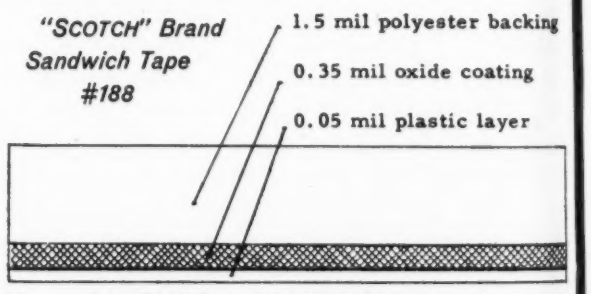
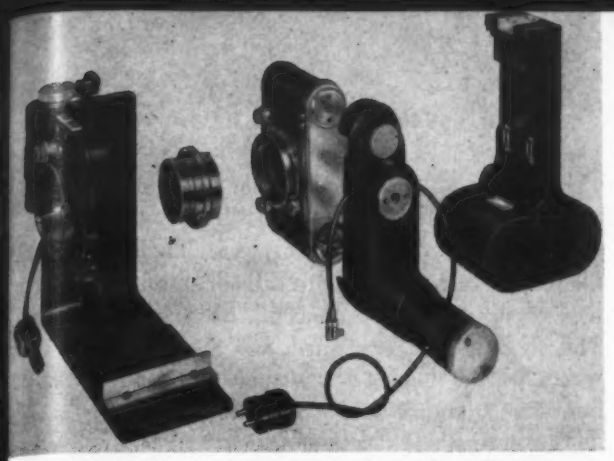


FIG. 1. SANDWICH CONSTRUCTION coats oxide on magnetic tape with protective plastic layer to reduce instrumentation recording errors and extend tape's lifetime.

Increased life from 10 to 1000 times that of conventional tape, depending on the recording system, is reported for the new tape by computer manufacturers. Down-time of computers for head cleanup is also said to be greatly reduced. At 1-mil wavelengths, the 50 μ-in. film reduces the signal level approximately 6 db. Medium and long wavelength responses are essentially unaffected. Three types—for standard output, above standard output level, and for longer recording time—available in the new construction are recommended for AM, PDM and some FM applications. Detailed specifications on the new tapes are available upon request.

For this literature circle **119** on inquiry card.



G. 1. **BASIC** Electro-Automatic Recording System, exoded view (left to right): KULI universal mounting supart with solenoid; Lens; ROBOT camera; Electric booster otor; and camera back with 30 ft film capacity.

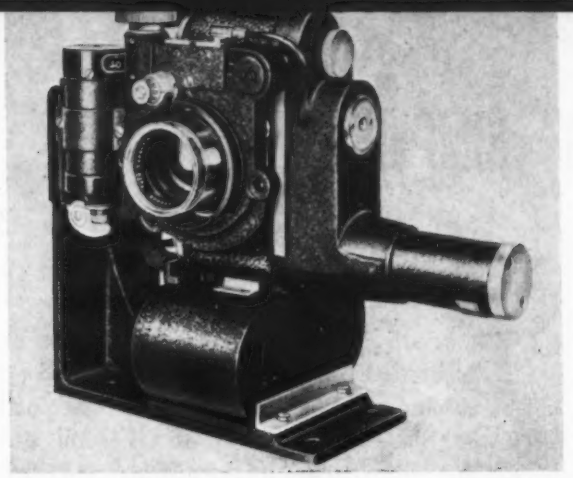


FIG. 2. ROBOT Electro-Automatic Recording System, assembled.

Registration Photography—Military Applications

ORIGINALLY conceived as an aerial camera for traffic control, bomb strike confirmation, target spotting, aerial mapping, aerial reconnaissance and instrument recording on piloted or unmanned planes, the Robot system of registration photography has ever since conformed to minimum weight and dimension requirements set by military aircraft designers. Sturdy construction, reliability and large film capacity also have qualified it as standard ground equipment. It is widely used for weather reporting, recording of radar indications, in wind tunnels, for anti-aircraft practice firing (with or without ammunition), and in the study of special take-off and landing procedures.

Many manufacturers of oscilloscopes, ultra-sonic impulse generators, radar and sonar instruments, etc., supply the Robot camera system as standard equipment. Transient waveforms, whose appearance cannot be pre-determined, can be recorded by the Robot's subject activation mechanism. With ultra-sonic testing devices the Robot can photograph each item being tested and provide a simultaneous record of the entire test operation.

The Robot's automatic operation has special value when working with subjects inaccessibly or inconveniently located. With its underwater housing, the camera can be lowered into deep water to check pier supports, quay walls, ship moorings, ship bottoms and buoy fastenings. This same housing also can be used to study marine life and sea floor photography with or without flash.

Other military applications include the use of multiple Robot units on missile-tracking theodolites, to read target images and angles simultaneously at all points of observation. For checking gun strikes, thin glass plates with engraved cross hairs and concentric circles for placing inside the camera just in front of the film plane are used to determine distance, trajectory and elevation on the resulting photographs.

The internal mechanism of the Robot consists of a built-in spring motor which drives the shutter, advances the film exactly one frame length, counts the exposures and keeps the shutter tension automatically set for the next frame. Exposures may be made singly or in any timed sequence from 6 exposures per second to one exposure every 24 hours (by instrumentation), or even by subject activation where the system is set to respond to a particular reaction of the part of the subject being studied. For example, the Robot automatically registers cathode ray tube transients up to a speed of 75"/μsec, using a P11 scope screen operated at 9 kv.

Standard frame sizes permit a choice of 18 x 24, 24 x 24, and 24 x 36 millimeters. Also on special order a frame width of only 1 mm, to photograph the headlines only of electronic computer punch cards, can be supplied.

An example of the supportive equipment comprising the Robot system is shown in Fig. 1 which shows an exploded view of the basic Electro-Automatic recording system. Fig. 2 shows the same components assembled. The Robot Royal 36 camera can either be used by itself or with the electro-automatic recording system. Schneider and Zeiss lenses from 30 to 300 mm in focal length and in apertures to f/1.9 are available. The Kuli mounting support enables a quick change of camera bodies during a recording sequence to permit reloading.

United States agent for the Robot photographic registration system is Karl Heitz Inc., 480 Lexington Avenue, New York 17, N. Y.

For more information on the Robot circle **120** on inquiry card.

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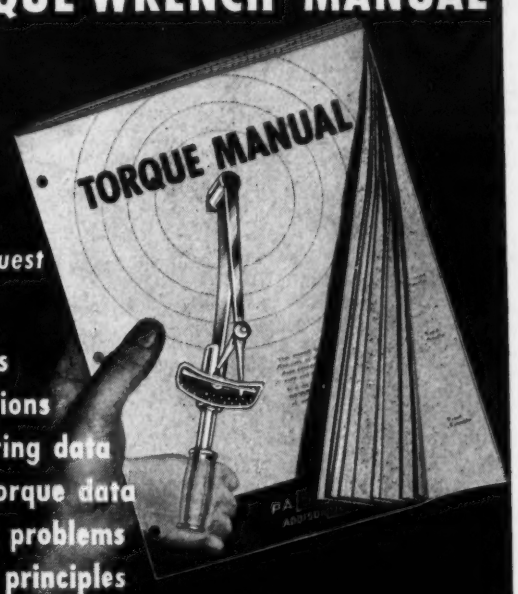
"TORQUE WRENCH" MANUAL



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HELICOPTER "BLADE TRACKING" SIMPLIFIED

FIG. 1. ELECTRONIC WM-1 BLADE TRACKER is shown in tracking position. Pickup head is under the rotor and the computer is in the right foreground.

"BLADE TRACKING", an important operation in the maintenance of helicopters, will be accomplished electronically when new WM-1A Electronic Blade Trackers, in experimental use by the military since 1956, are furnished to operational Naval and Marine Helicopter Units later this year.

Tracking is made necessary due to the nature of helicopter blades. Compared to blades of an electric fan, helicopter blades are very long, narrow and flexible. They also must be made adjustable to enable forward, backward or lateral motion to be controlled.

Under ideal conditions, helicopter blades, like those of a fan, rotate in a singe plane, called a "track". An "out of track" condition comes about when one or more of the blades rotates in a plane that is different from the others. The result often is inferior performance and severe vibration. Blade tracking, therefore, is the process of determining whether or not the blades are traveling in the same plane.

Previously blade tracking has been done manually, using a canvas "flag." A different colored chalk or dye is put on the tip of each blade. When the blades are rotating at prescribed speed, the flag is moved so that it is "ticked" once by each blade. The flag then is examined and the chalkmarks tell which of the blades are displaced or out of track, how much, and in which direction.

The new Blade Tracker which makes these measurements electrically has a number of important advantages. The most prominent ones are higher accuracy ($\pm$ 1/8"), capability for use in inclement weather and under gust wind conditions, savings in manpower, and safety.

As shown in Fig. 1, the Electronic Blade Tracker, Model WM-1A, is used as a tool in the hands of the helicopter line maintenance crew with the helicopter on the ground. Its developers, the Chicago Aerial Industries, 1980 Hawthorne Ave., Melrose Park, Ill., are now engaged in further work along this line leading to airborne tracking devices and other sensing systems for rotor head analysis and optimizing the performance of helicopter blades while in flight.

For more information on the Blade Tracker circle **121** on inquiry card.

Pulse Magnetic Amplifier Operation

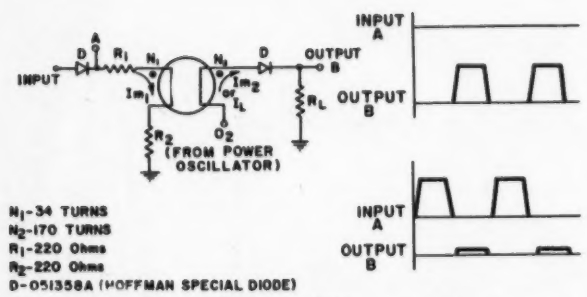


FIG. 1. POWER OSCILLATOR and output waveshapes.

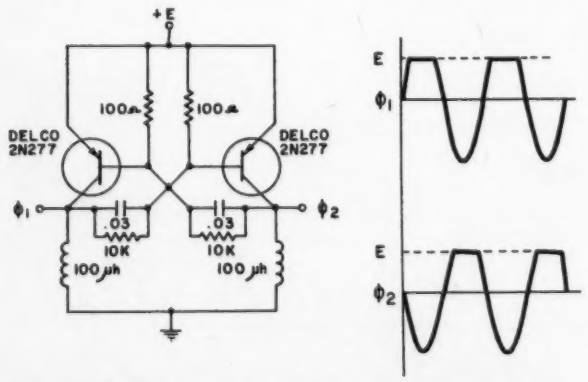


FIG. 2. BASIC complementing pulse magnetic amplifier.

Fig. 2 is a schematic diagram of a basic complementing pulse magnetic amplifier. The power connection indicated at ϕ_2 is taken from the power oscillator shown in Fig. 1.

The circuit shown is a binary device capable of having only two output conditions. These two conditions are the presence of a voltage pulse known as '1' and the absence of a pulse known as '0'. If the magnetic core is in the set condition, that is, at $+B_r$ when ϕ_2 is applied, a '1' appears at the output. The total voltage is dropped across load resistor R_L. No voltage appears across winding N_2 because the core is saturated. If the magnetic core is in the reset condition, that is at $-B$ when ϕ_2 is applied, a '0' appears at the output. The total voltage appears across the winding N_2. This condition exists because the core is being set. That is, the hysteresis loop is being traced from $-B_r$ to $+B_m$. A small voltage does appear across the load resistor due to the magnetizing current (NI_m).

The desired output is determined by the signal fed to the input. The input signal also is binary in nature and may be either a '0' or a '1'. The input signal has a 180° phase relationship to the output signal. The input signal is in phase ϕ_1, and the output signal is in phase ϕ_2. Therefore, the input places the magnetic core in a state that determines what the output will be one half cycle later. If there is no input during the period of ϕ_1 positive, one half cycle later an output occurs during the positive excursion of ϕ_2, in the manner previously described. An input during the period of ϕ_1 positive, resets the magnetic core and no ϕ_2 output is present in the following positive ϕ_2 time period as explained previously. This illustrates three important characteristics of the pulse magnetic amplifiers. First, the amplifier is complementary, that is, the output is opposite from the input. When the input is a '1' the next output is a '0'. When the input is a '0' the next output is '1'. The second characteristic is the intrinsic time delay of the amplifier. That is, the output dictated by a given input occurs 180° later in time than the input. And third, power is not transferred through the core by transformer action but is gated by controlled saturation. When the core is saturated, winding N_2 offers only the resistance of the wire to ϕ_2. When the core is not saturated, winding N_2 offers the impedance determined by equation (3):

$$R_o = \Delta BA\ 10^{-2}/NI_tL\ T_s\ \text{ohms/turn}^2$$

where ΔB is lines per square inch, A is cross-sectional area in square inches, NI_t is ampere turns per inch. T_s is switching time in microseconds, and L is mean length of magnetic path in inches. Equation (3) is used to determine power loss in the core and the voltage drop across the windings. (*From 8-page engineering treatise on Pulse Magnetic Amplifier Design and Logic Circuits, Hoffman Semiconductor Application Notes, Vol. 1 Nos. 5 & 6, June, 1958, Hoffman Electronics Corp., Semiconductor Div., 930 Pitner Ave., Evanston, Ill.*)

For more information on this literature circle **122** on inquiry card.

Hi-Capacity Missile Power System

A new integrated power system for aircraft and missile applications, consisting of a 12,000-rpm wound-field alternator with integral permanent-magnet exciter, employs a completely static magnetic-amplifier voltage regulator notable for its rapid response. It also features voltage regulation within 1% during changes of load, temperature, and environmental conditions, small size, light weight and rugged construction. Rating specifications are shown in Fig. 1.

An elementary diagram of the regulating system is given in Fig. 2. The a c supply voltage for the magnetic amplifier is obtained from an 800-cycle permanent-magnet exciter mounted on the main generator shaft. This exciting power is completely independent of the main ac output voltages and its high frequency allows a small magnetic amplifier to be employed in the regulator. Low capacitance of the silicon rectifiers makes them suitable for use with magnetic amplifiers operating from a high frequency source.

For short periods of time, the alternator may be operated with no cooling whatsoever to meet a condition encountered at extremely high altitudes where atmospheric pressure is negligible and cooling air is not provided. Starting with an initial temperature of 100°F, the unit may be operated under the condition of no cooling and at rated load for about eight minutes.

Quick voltage-build up without the use of external power for "field flashing" required by many types of static excitation systems, and the recovery of system steady-state voltage within 50 milliseconds on application or removal of full load with an overshoot of only 12%, is accomplished by the light-weight regulator unit. Use of silicon rectifiers and high temperature insulations enable operation from —55° to 100°C without cooling. For applications where vibrations are in excess of Mil-E-5272A, the voltage reference tube has been replaced with a zener diode reference and a transistor preamplifier. (*From new 8-page bulletin GET-2743, 10-kva Aircraft and Missile Electrical System, General Electric Co., Schenectady 5, N. Y.*)

For this literature circle **123** on inquiry card.

Model Number	Alternator: 5ATI31VJ Regulator: 357933NA120
Rating	Up to 10 KVA, .8 Power factor
Overload	Up to 13.5 KVA, .8 Power factor; for short periods of time with adequate cooling
Rated Load Duty Cycle	Continuous with forced-air cooling; 10 minutes of thermal sink operation
Voltage	115/200, 3 phase, 4-wire system
Frequency	400-cycle
Speed	12,000 rpm
Voltage Regulation	Less than ± 1%
Environmental Specifications	MIL-E-5272A
Electrical Performance: Harmonic Content, Phase Displacement, Wave Form, Amplitude Modulation, Recovery Time	Surpasses requirements of MIL-G-6099A
Radio Interference	MIL-I-6181B
Full Load Efficiency (including excitation requirements)	85%

FIG. 1. POWER SYSTEM rating specifications.

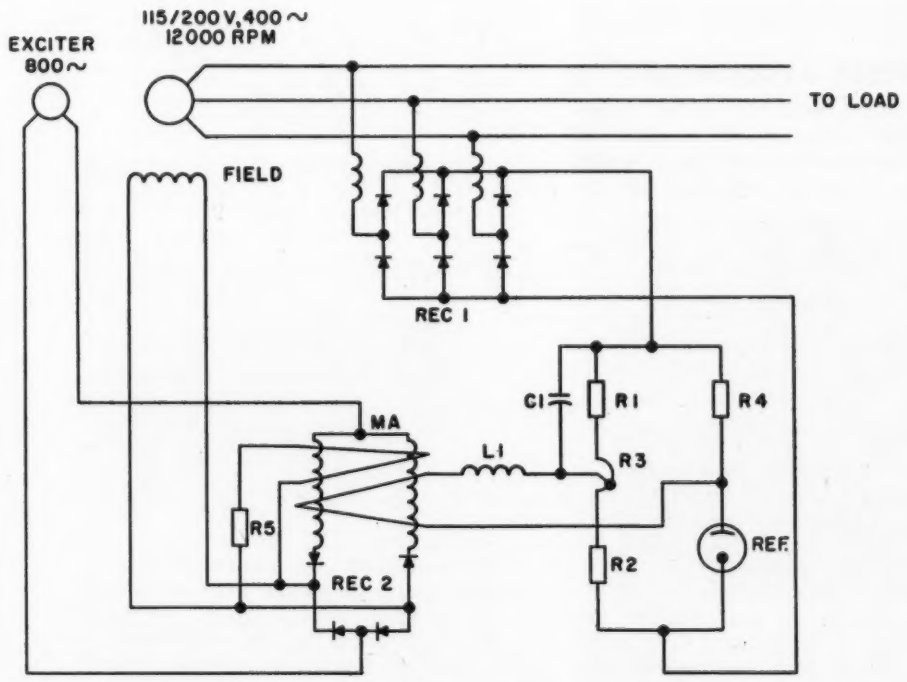


FIG. 2. REGULATOR CIRCUIT shows how 400 cps output is converted to dc for use in one winding of magnetic amplifier. Field current, from 800 cps permanent-magnet exciter, gives quick voltage build-up.

DISTANCE DETECTOR

This Distance Detector is a precision electro mechanical transducer which generates a dc voltage as a function of distance. It is an all transistor design to provide reliability, long life, and low energy consumption.

A very high sensitivity gradient and fast response make it a particularly precise and versatile unit for a vast variety of micro-distance measuring jobs.

OPERATION: This device senses distance to a conductive surface because of the variation of coupling coefficient as a function of distance from the face of a special coil to the conductive surface.

SENSITIVITY: 1000 volts per inch with H-1 sensing head
400 volts per inch with H-2 sensing head
200 volts per inch with H-3 sensing head

RANGE: 10, 25 and 50 thousandths of an inch, with head types 1, 2, and 3 respectively.

RESPONSE: Flat from dc to a single lag at 50,000 cps.

SUPPLY: 12 vdc at 2ma

SIZE & MASS: 1.2" diameter x 2.5" long, 80 grams

COST: Model 15, $72.00 with H-2 head. Additional standard heads $6.00 each.

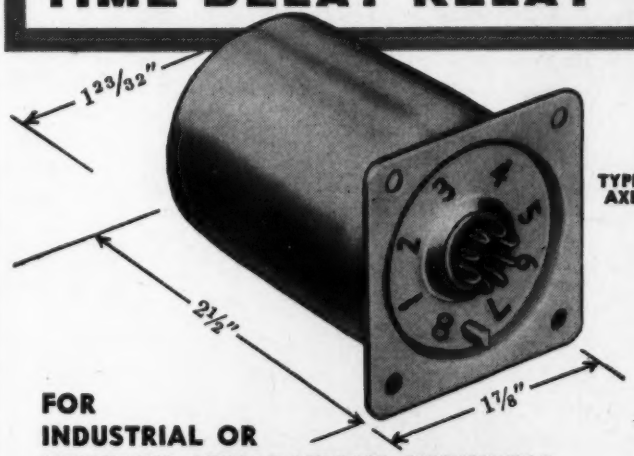
USES: Typical uses are control of location and indication and measurement of dimension, displacement, deflection, velocity, vibration, contour, creep, and counting.

BENTLY SCIENTIFIC COMPANY

2811 Seventh Street
Berkeley 10, California
Phone: Thornwall 3-6306

For more information circle **33** on inquiry card.

EAGLE "Mil-Spec" Precision TIME DELAY RELAY



FOR INDUSTRIAL OR MILITARY APPLICATIONS REQUIRING 2000 cps VIBRATION TESTS

SPECIFICATIONS

a. Operates during 5 to 2000 cps, 10G vibration.
b. Operates —55° to +125° C.
c. Withstands 30G 11ms shock.
d. D.C. operating coil. Wgt. 9 oz.
e. Hermetically sealed.
f. Timing not affected by voltage variations.

Write for descriptive Bulletin No. 820. Address Dept. MA-1058.

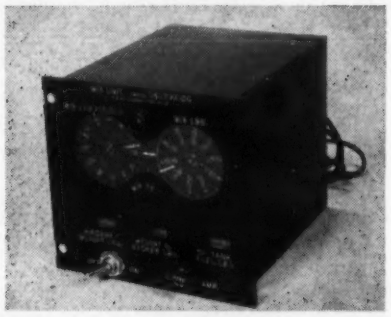
EAGLE SIGNAL CORPORATION
Industrial Timers Division • Moline, Illinois

For more information circle **34** on inquiry card.

MA New Products

CRUISE CONTROL INSTRUMENT

New W/delta meter developed by Maxon for Naval Air use computes the ratio of instantaneous weight to altitude from manual inputs of con-

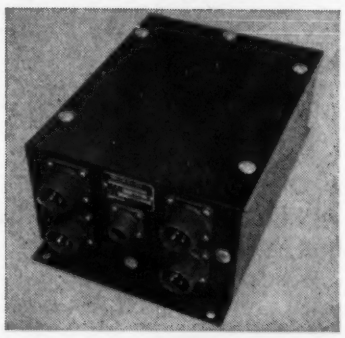


stant aircraft and stores weights, combined with automatic inputs of aircraft altitude and fuel weight. The W/delta quantity provides a parameter for analyzing aircraft performance which is better than altitude alone. The pilot can fly an optimum constant W/delta or record his actual W/delta at any time during the flight. The transistorized servo amplifier used is said to have a reliability test record of 8000 operation hours under environmental conditions. —*The W. L. Maxon Corp.*, 475 *Tenth Ave., New York* 18, *N. Y.*

For more information circle **124** on inquiry card.

SQUIB FIRING DEVICE

New Microloc #51050 Energy Storage Firing Device converts a low current 28-v signal input into a high cur-

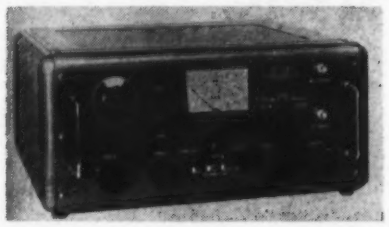


rent output to simultaneously fire a number of electric squibs in parallel. Reliable ignition from signals normally used only for relay operation becomes possible, also explosive circuit is shielded from transients.—*Microloc Corp.*, 5808 *Marilyn Ave., Culver City, Calif.*

For more information circle **125** on inquiry card.

TWT AMPLIFIER

New Model TWT-10 CM radar amplifier, designed specifically for use with the RCA type A1079 tube, also

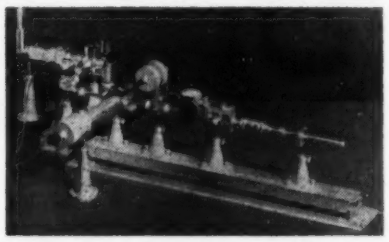


accommodates other types covering a frequency range from 1.1 to 4.3 kmc. A high-sensitivity relay circuit protects the helix; noise figures of less than 7 db are claimed over a wide band of frequencies.—*LEL, Inc.*, 380 *Oak St., Copiague, L. I., N. Y.*

For more information circle **126** on inquiry card.

"Q" BAND COMPONENTS

New Hilger and Watts 8-10 mm waveband units include mechanically tuned klystrons, SWR indicators,

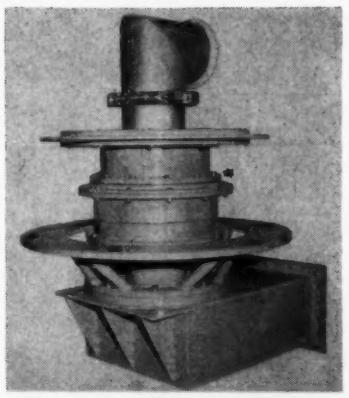


wavemeters, thermistors with mounts and precision attenuators with U. S. type flanges. Used in high accuracy, high resolution radar and wide-band communications.—*Dept. K-5, British Industries Corp., Port Washington, N. Y.*

For more information circle **127** on inquiry card.

HI-POWER ANTENNA JOINT

New rotary joint for radar microwave and scatter communications which converts from WR2100 waveguide to 9" coaxial, handling 100 kw

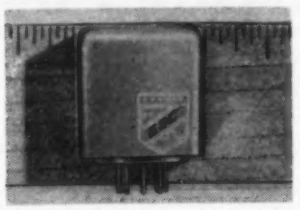


average power in the 400-450 mc range, has a maximum VSWR of 1: 1.15. Other units engineered for specific applications are under production up to ½ megawatt average power.—*G. B. Electronics Corp.*, 711 *Stewart Ave., Garden City, N. Y.*

For more information circle **128** on inquiry card.

MINIATURE PULSE GENERATOR

New Modupulser unit for plug-in operation, allows quick pulse-rate change by stocking units with vari-



ous pulse rates for quick insertion. Pulse widths from 1.0 to 8.0 μsec; PRF range 400 to 15,000 cps; output ±6 v when operated from 6 v dc source.—*ESC Corporation, Electronic Components Div.*, 534 *Bergen Blvd., Palisades Park, N. J.*

For more information circle **129** on inquiry card.

C-BAND ISOLATOR

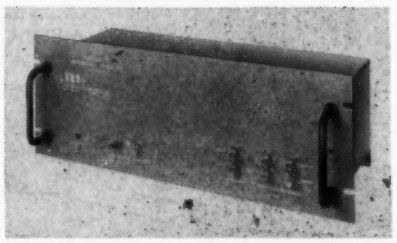
New Model W277-52-4 Ferrite isolator operating over the 5.9 to 6.5 kmc range achieves 40 db isolation

with less than 1.0 db insertion loss over the entire range. Integral magnets do not extend beyond the flange area. Peak power capabilities are up to 10 kw with an average power rating of 10 w for data link applications. Specifications on request.—*Kearfott Co., Microwave Div.*, 14844 *Oxnard St., Van Nuys, Calif.*

For more information circle **130** on inquiry card.

KILOMEGACYCLE REFERENCE

New Manson Model RD-170 ultra-precise but low-cost unit for reference, monitoring or calibration gen-

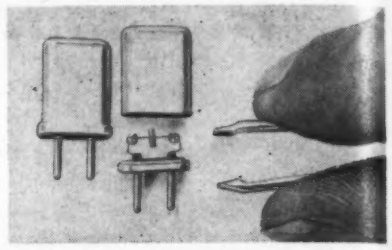


erates sinusoidal frequencies of 100 mc and 1000 mc, also harmonic signals covering much of microwave spectrum. Free-running 100 mc generator is phase-locked by 1 mc reference stabilized to 1 part in 10^6/day. Output power is 100 mw @ 50 ohms.—*Manson Labs., Inc., Dept. M, P. O. Box* 594, 207 *Greenwich Ave., Stamford, Conn.*

For more information circle **131** on inquiry card.

SUB-MINIATURE CRYSTALS

New frequency control and filter crystals in the 300 kc to 125 mc range

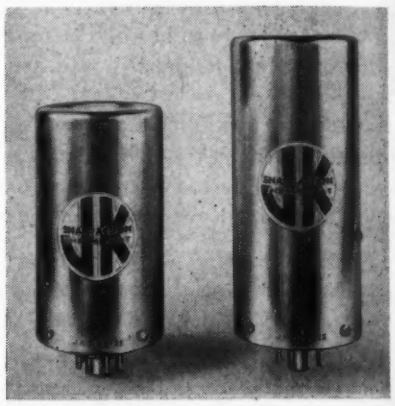


occupy only a small part of space in military HC 18/u case. Special manufacturing techniques permit great reduction in size needed when monycrystals are used in a single unit.—*Sherold Crystals, Inc.*, 1512 *McGee Trafficway, Kansas City, Mo.*

For more information circle **132** on inquiry card.

CRYSTAL OVEN

New type JKO 13S oven, featuring disc thermostat with "snap action", meets military environmental



specs, providing operating temperatures from 55° to 125°C with a temperature stability of ± 1.0%. Heater operates on 12-115 v with fast warm-up.—*James Knights Co., Sandwich, Ill.*

For more information circle **133** on inquiry card.

FREQUENCY-SELECTIVE VOLTMETER

Analysis of subcarrier signal amplitudes in frequency-division multiplex systems is feasible with new Model 2174 heterodyne instrument with integral voltmeter, crystal fil-

ters and internal calibrating oscillator. Portable for laboratory or field use, requires 115 v 50/60 cps supply. —*Rycom Inst. Div., Railway Communications, Inc.*, 9351 *E. 59th St., Raytown* 33, *Mo.*

For more information circle **134** on inquiry card.

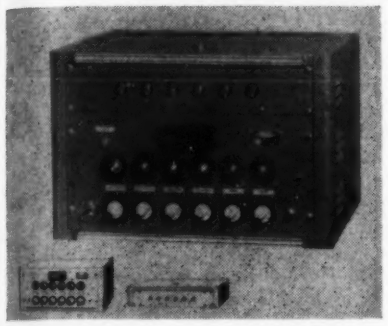
MULTI-CIRCUIT CYCLE TIMER

New Model WD multicircuit timer controls, including sequence of operations in separate circuits, are all set on the face of the timer. Each circuit control has 96 non-removable tripping clips giving 48 possible "on" and "off" operations independent of other circuits. One motor drives and synchronizes all controls.—*Zenith Electric Co., Dept. IAP, 152 West Walton St., Chicago 10, Ill.*

For more information circle **135** on inquiry card.

COUNTER HAS NIXIE READOUT

New Decitron electronic counter for high-speed counting with enlarged

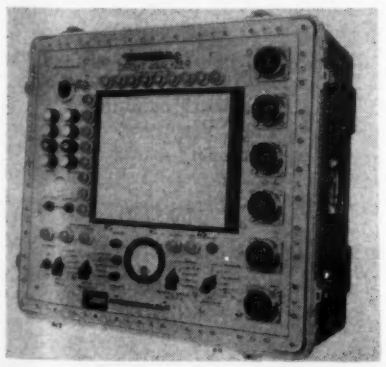


visual totalizer, operating with any Post photohead or magnetic pickup, mounts in-line readout unit in same cabinet or in remote position. Pulses to drive counter must be 5-30 v, 50 usec long (min), of any shape.—*Post Electronics, Beverly, Mass.*

For more information circle **136** on inquiry card.

AN/USM-88 CIRCUIT ANALYZER

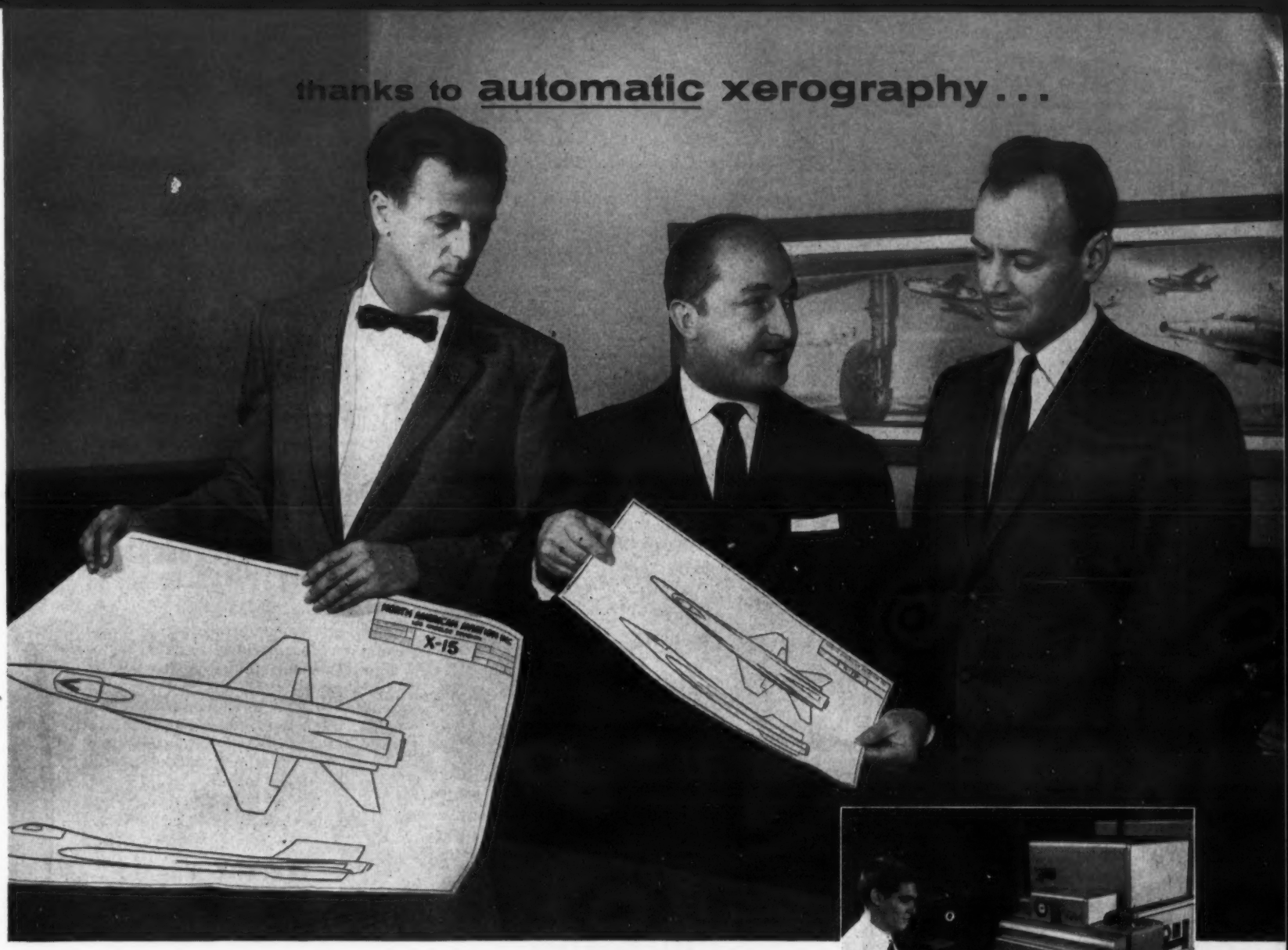
Said to be first universal automatic analyzer assigned an AN/- number, DIT-MCO model 144 for ground support use with capacity of 144 circuits, tests all types of complex circuits for shorts, continuity



and insulation flaws; also functionally tests relays, solenoids, actuators and other resistive devices at a rate of 10 circuits/sec. Visible matrix chart instantly locates defects. Meeting requirements of MIL-T-945A, it has operated for days submerged in a tank to illustrate its ability to operate in unfavorable environments. —*DIT-MCO, Inc., Electronics Div., 911 Broadway, Kansas City 5, Mo.*

For more information circle **137** on inquiry card.

thanks to **automatic** xerography . . .



Above: Harrison Storms, right, chief engineer at North American Aviation's Los Angeles division, examines 11" wide engineering-drawing reduction of the company's rocket-powered X-15 made xerographically on XeroX Copyflo 11 continuous printer. Buzz Holland, center, manager of photographic and reproduction services, explains process to Storms while Mark Keith, reproduction supervisor, holds 24" x 36" original drawing.

Inset: Ron Crawford inserts a 24" wide original drawing into Copyflo printer, which within seconds will deliver a dry, positive print into tray below.

North American Aviation *SAVES* $100,000 Yearly

North American Aviation, Inc., has figuratively gone supersonic in the rapid reproduction of engineering prints for high-speed aircraft.

This widely known aviation firm is one of the first in its field to install a XeroX® Copyflo® continuous printer, an ingenious machine that copies thousands of *different* drawings in a normal working day. Positive prints up to 11" wide emerge dry, ready for immediate use, at the rate of 20 linear feet a minute—a print in less than three seconds!

North American Aviation, Inc., is saving more than $100,000 annually through automatic xerographic copying, easily paying for the equipment the first year.

The Copyflo continuous printer accepts original documents or drawings up to 24 inches wide and of any length, and reduces or enlarges them to a maximum width of 11 inches. Copies are on plain unsensitized paper, offset paper masters, or translucent vellum. Originals may be in type, pencil, colored ink, or on tinted paper, yet copies will be precisely like the originals.

Simply push a button—and copies flow. Through versatile xerography—clean, fast, dry, electrostatic—Copyflo printers offer the speediest, most flexible, most economical way to get sharp, clear copies from all types of original documents or from microfilm.

For complete information write Haloid Xerox Inc., 58-208X Haloid St., Rochester 3, N. Y. Branch offices in principal U. S. and Canadian cities.

HALOID XEROX®

For more information circle **35** on inquiry card.

Dynisco

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TRANSDUCER

Incorporates
Unbonded Strain Gauge

HIGHLIGHTS

► EXTREMELY SMALL FLUSH-MOUNTED PRESSURE DIAPHRAGM

► HIGH NATURAL FREQUENCY

► ½ % ACCURACY

► STANDARD UNITS GUARANTEED AND TESTED TO +300°F

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PRESSURE RANGES
PT 31 0-300 to 0-5,000 PSI
MOUNTS IN 5/16-24 THREADED HOLE
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PT 32 0-6,000 to 0-15,000 PSI
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For more information on Dynisco pressure, force, flow, and displacement pickups, write:

DYNAMIC INSTRUMENT CO.
42 Carleton Street
Cambridge 42, Mass.
UN 4-7260

For more information circle **36** on inquiry card.

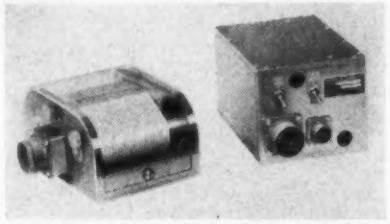
MINIATURE TV CAMERA

New ultra-small TV camera, first delivered to Signal Corps, also is available in industrial version. Although previous high definition systems weighed over 100 lbs and required separate control, power and sync generator units, new Dage transistorized camera packs all components into a book-size package weighing about 4 lbs, exclusive of lens. Separate potted plug-in modules provide video amplifier, sweep amplifier, sync generators, binary strip, power supply and oscillator strip.—*Dage Television Div., Thompson Products, Inc., Michigan City, Ind.*

For more information circle **138** on inquiry card.

EVENT RECORDER

New events recorder continuously monitors 21 channels of operations

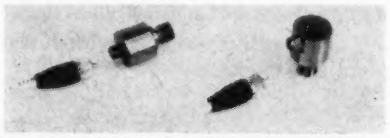


on 3½" wide, 100 ft long teledeltos chart. Chart speeds up to 8"/sec are available, from 28 v governor-controlled motor. Associated power supply for teledeltos recording is optional.—*Photron Instrument Co., 6516 Detroit Ave., Cleveland 2, Ohio.*

For more information circle **139** on inquiry card.

HIGH-SENSITIVITY ACCELEROMETERS

Self-generating accelerometers for shock and vibration using a new piezo-electric ceramic for flat response over temperatures from —70° to 250°

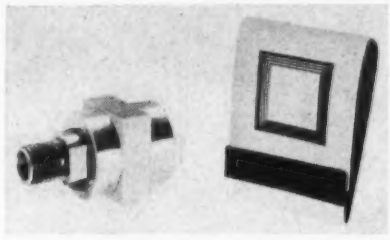


F are available in either grounded or integrally ungrounded designs. The A-380 Series have an acceleration range from 0.05 to 500 G and a useful frequency range of 3 to 2,500 cps, with resonance at 10,000 cps. The A-395 Series has ranges from 0.1 to 800 G, from 3 to 9.000 cps, and resonance at 30,000 cps. Both series have a sensitivity of 40 mc/G minimum and capacitance with cable of 1200 $\mu\mu$f minimum, are available in either aluminum or titanium housings.—*Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.*

For more information circle **140** on inquiry card.

MISSILE PRESSURE TRANSDUCER

New miniature TP-100 transducer uses counterbalanced elements to measure absolute, gage or differential pressures in instrument ranges from 0-5 psi to 0-350 psi with a linearity of ±1%. Resolution in most ranges is 0.25%. Acceleration of 40 G and vibration of 2000 cps at 15 G are said



to cause less than 1% output signal error.—*Components Div., Fairchild Controls Corp., 225 Park Ave., Hicksville, N. Y. or 6111 E. Washington Blvd., Los Angeles 22, Calif.*

For more information circle **141** on inquiry card.

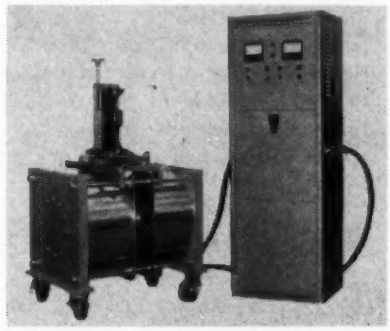
MISSILE COMPONENT TEST TABLE

New Test Table being used in Bomarc program for pretest of missile components provides angular motion simultaneously in azimuth, rock and tilt axes. Can be adapted to remote control, operates on continuous duty cycle, and uses solderless connectors to speed installation of major components and functional modules under test.—*Ideal-Aerosmith, Inc., Dept. J., 3913 Evans Ave., Cheyenne, Wyo.*

For more information circle **142** on inquiry card.

LABORATORY MAGNET

New magnetic research magnet has 11" pole diameter providing air gap flux densities to 20,000 gauss. Gap width may be continuously ad-



justed from 0 to specified value. Accommodates either vertically or horizontally mounted specimens.—*Advance Industries, Inc., 640 Memorial Dr., Cambridge, Mass.*

For more information circle **143** on inquiry card.

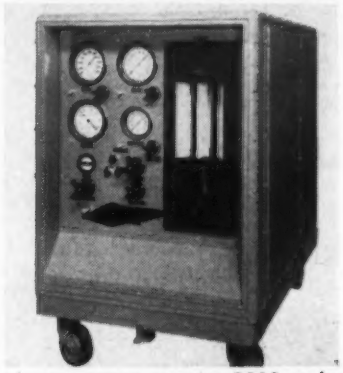
MAGNETIC CORE TESTER

New Variable Frequency magnetic amplifier core test set meets new AIEE standards, using constant-current flux-reset method at any frequency from 60 to 3000 cps. Bulletin 98-1 with complete description available on request.—*Briggs Associates, Inc., 10 DeKalb St., Norristown, Pa.*

For more information circle **144** on inquiry card.

MISSILE HYDRAULICS SYSTEM TEST

Model 9440 Hydraulic Test Cart, for production checkout of missile hydraulic systems delivers 10 gpm of

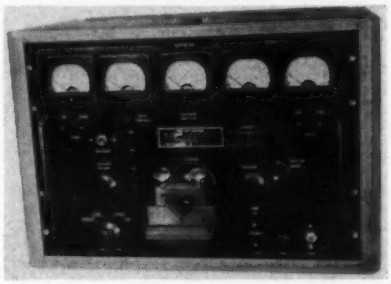


oil at pressures up to 3000 psi and provides automatic back pressure on the missile hydraulic system to within ±1 psi. Two heavy-duty, removable-cartridge filters also provide for initial flushing of system components. The test cart is mounted on castors for portability.—*Geo. L. Nankervis Co., 15300 Fullerton Ave., Detroit 27, Mich.*

For more information circle **145** on inquiry card.

MOTOR TEST SET SERIES

New test equipment designed to test bomb computer servo-motors is

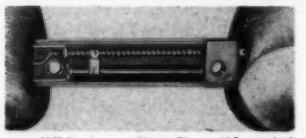


adaptable to wide range of customer's motor test requirements; features 0-40 rpm tachometer, direct reading backlash indicator, and voltage and current monitors in control and fixed phases of the motor. Can detect any drop-off in performance which may occur in service or storage.—*North Atlantic Industries, Inc., 603 Main St., Westbury, N. Y.*

For more information circle **146** on inquiry card.

SUBMIN TRIMMER POTS

New A10-W wirewound trimmer pot in resistances from 10 to 30K ohms ± 5% tolerance, operating

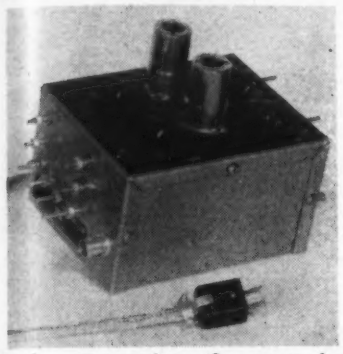


range —55° to 150°C will withstand the most demanding environmental conditions. Types B11W and C12W types are commercial and low-cost types for less severe applications. Detailed specifications on request.—*Dale Products, Inc., Columbus, Nebr.*

For more information circle **147** on inquiry card.

ULTRASONIC TRANSDUCER PREAMPLIFIER

New PA-620 preamplifier provides tuning coil to resonate with transducer from 6-70 mc, improves the S/N

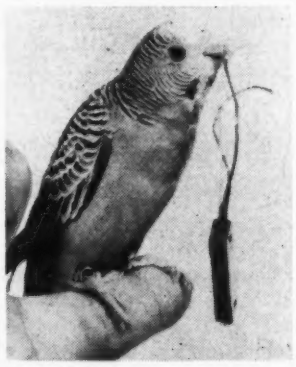


ratio by narrowing the pass band, and provides a lightweight pickup head which may be placed close to object under test, while main amplifier, WA-600, at some distance provides power for the preamplifier. Technical specifications are provided in bulletin TE3(58).—*Arenburg Ultrasonic Lab., Inc.*, 94 *Green St., Jamaica Plain* 30, *Mass.*

For more information circle **148** on inquiry card.

FOR MISSILE "BIRDS"

Model 224 Trimpot pot, so small that 16 fit in 1 sq-in of panel space,



has rating of 1 watt at 70°C and ½ watt at 125°C. Plastic case gives humidity resistance exceeding MIL-STD-202A.—*Bourns Laboratories, Inc., P.O. Box* 2112, *Riverside, Calif.*

For more information circle **149** on inquiry card.

RECTILINEAR POTENTIOMETER

New Series RP-125 miniature trimming resistor available in complete range of resistances is 1¼" in length,

meets MIL-R-19 environmental requirements.—*Electronic Sls. Div., DeJur-Amsco Corp.*, 4501 *Northern Blvd., Long Island City* 1, *N. Y.*

For more information circle **150** on inquiry card.

Circle **37** on inquiry card. →

50,000 hours

...A record six-year period of continuous computer-tube operation... by General Electric 5844's, the industry's first computer tube!

FEW well-planned tests are discontinued because they have become pointless. This one was *—after nearly six years.* A large computer manufacturer placed General Electric 5844 twin triodes on continuous life test under actual operating conditions. After 50,000 hours the test was terminated . . . because tube failures (a small fraction of 1 percent per thousand hours) were too few to warrant further statistical recording.

From more than a million General Electric 5844 computer tubes in actual service, the manufacturer reports a failure rate that is equally low—approximately 0.2 percent per 1,000 hours.

Look to tubes for proved dependability! Reliable long-life performance is a feature of all nine General Electric specially-designed computer types. For your military or commercial needs, specify from the list that follows! Additional facts are available from any office of the G-E Receiving Tube Department listed below.

COMPUTER TUBE TYPE	CLASSIFICATION	HEATER CURRENT IN ma, AT Ef = 6.3 v	DESIGN-MAXIMUM DC CATHODE CURRENT PER SECTION, IN ma	DESIGN-MAXIMUM PLATE DISSIPATION PER PLATE, IN WATTS	TYPICAL APPLICATION
5844	Twin triode	300	10	1.0	Medium-speed counter
5965	Twin triode	450	16.5	2.2 4.0 (a)	High-speed counter or amplifier
6211	Twin triode	300	14	1.3	Medium-speed counter
6350	Twin triode	600	40	3.5 6.0 (a)	High-speed counter, amplifier, or core-driver
6414*****	Twin triode	450	17	2.0 3.6 (a)	High-speed counter or amplifier
6463	Twin triode	600	30	4.0 7.0 (a)	High-speed counter, amplifier, or core-driver
6829*****	Twin triode	450	20	2.2 4.0 (a)	High-speed counter or amplifier
6919	Twin diode	200	10 (b)	...	Gate or clamp
7036	Heptode	300	16	0.75	High-speed gate

***** 5-Star high-reliability tube, built to a MIL spec.

(a) Total both plates.

(b) Maximum DC output current per plate.

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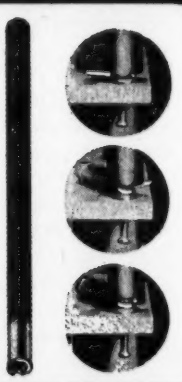

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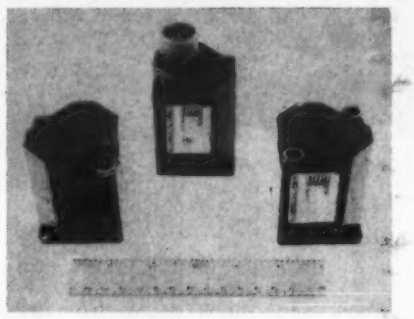
For more information circle 38 on inquiry card.

FLOATED RATE GYROS

New AiResearch 210 Series gyros capable of withstanding 150 G shock or acceleration operate from dc or

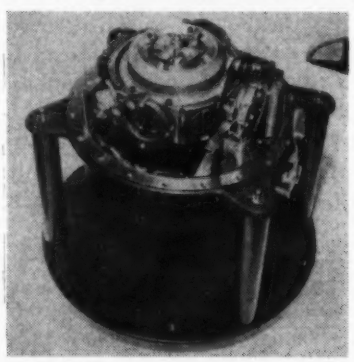


single or multiphase ac from 350 to 2500 cps. Damping is held nearly constant by silicon oil flotation over an ambient temperature range from −67° to 165°F. No rate springs or heaters are employed. Operating life ranges from over 150 hrs for dc units to more than 1000 hrs for ac models.—*AiResearch Mfg. Div., Garrett Corp.*, 402 *S.* 36 *St., Phoenix, Ariz.*

For more information circle **151** on inquiry card.

DRONE GYRO

New N3200A two-axis cageable vertical gyro designed for drone applications to Specification MIL-C-7436A,



is maintained in vertical position by the precessive action of air jets which are controlled by gravity-sensing vanes on top of inner gimbal. Blower on rotor motor provides air. Pots on pitch and roll axes indicate displacements from vertical.—*Electronics Div., Iron Fireman Mfg. Co.*, 2838 *S. E. Ninth Ave., Portland* 2, *Ore.*

For more information circle **152** on inquiry card.

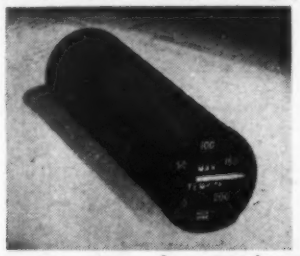
BINARY SHAFT ENCODER

New airborne ADC-BNRY shaft encoders employ special logic circuits within the encoder to eliminate electronics otherwise needed for double brush V-scan systems. Novel design is said to prevent commutation of load current on the disc, providing a long, noise-free life, yet to allow continuous or pulse readings at up to 200 rpm. Digit and complement are simultaneously available in unambiguous natural binary.—*Norden, Div. of United Aircraft Corp., Wiley St., Milford, Conn.*

For more information circle **153** on inquiry card.

MULTI-CHANNEL MAX/MIN BRIDGE

New servo-driven, self-balancing maximizing and minimizing bridge, designed to monitor temperatures, pressures, flow rates, voltage, and

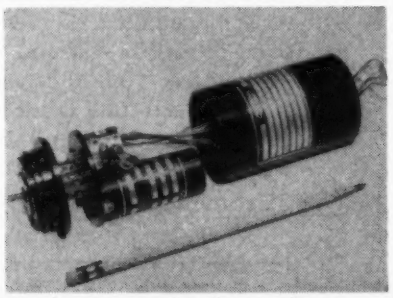


other parameters for maximum or minimum conditions can be supplied with long-range dial or without dial and pointer for telemetering. Any number of resistance type transducer inputs can be sequentially monitored to better than 0.5% accuracy of scale span. Response is 6 sec for 270 angular degrees; operating in −65° to 160°F ambients. Complete technical data in Bulletin P135 on request.—*Avien, Inc.*, 58-15 *Northern Blvd., Woodside* 77, *N. Y.*

For more information circle **154** on inquiry card.

TURRET SERVO ASSEMBLY

New turret servo assemblies are said to provide greater flexibility for

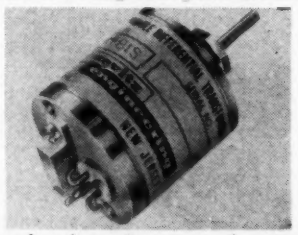


use of components, less volume, and better mechanical rigidty. Typical package shown contains size-11 motor tachometer, gearhead and potentiometer in case 5" x 2¼" OD.—*Mechatrol Div., Servomechanisms, Inc.*, 1200 *Prospect Ave., Westbury, N. Y.*

For more information circle **155** on inquiry card.

REMOTE ANGLE INDICATOR

New Model 4BIS RVDT (rotary variable differential transformer) designed for measurement and remote indication of angular position of mis-



sile and aircraft control surfaces, valves, etc., differs from previous models by addition of fifth terminal pin connected to junction of differential secondaries.—*Schaevitz Engineering, P. O. Box* 505, *Camden* 1, *N. J.*

For more information circle **156** on inquiry card.

16-WATT SERVO AMPLIFIER

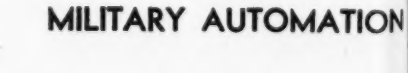
New high-powered 400 cps addition to Kearfott line, Model A3104, consists of 16 watt output push-pull

stage, driver push-pull stage, phase splitter, and voltage amplifier potted to withstand shocks 400% greater than required by the applicable Mil-Specs. Voltage gain is adjustable by external resistor from 100 to 2000 for a 40 v load, and through an impedance matching transformer, from 300 to 6000 for a 115 v load.—*Kearfott Co., Inc.* 1500 *Main Ave., Clifton, N. J.*

For more information circle **157** on inquiry card.

MISSILE THERMAL RELAY

New thermal relay for missile operation, of one-time-operating type, features hermetic seal, small size, and



positive operation; can be located near desired components. When an electric signal is triggered, constrained contact is released and permanently closes switch circuit.—*Hughes Products, International Airport Station, Los Angeles* 45, *Calif.*

For more information circle **158** on inquiry card.

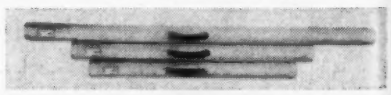
CUSTOM COMMUTATORS AND SLIPRINGS

New Tronex commutators designed to withstand the most severe functional and environmental conditions are fabricated to customer requirements. Typical specifications: Angular tolerance ±5 min.; brush noise, 3 mv at 5 amp; voltage breakdown, min. 1000 v ac; insulation resistance, 2,000,000 megohms, min.; conductor finish, 4 microinches; conductor hardness, 70 to 95 Brinell.—*Tronex Manufacturing, Inc.*, 66 *Brooklyn Ave., Westbury, N. Y.*

For more information circle **159** on inquiry card.

PRINT CARRYING CASE

New, lightweight, tamperproof aluminum Saf-Tee carrying case for rolled maps, drawings, plans and

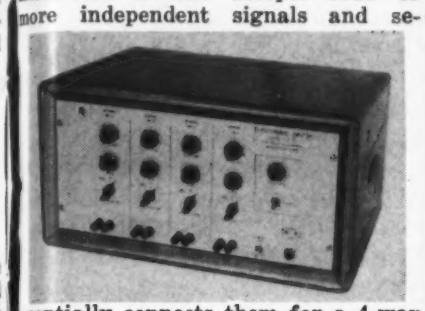


blueprints is available in 3 standard sizes, accommodates rolled subjects to 60." 16 gauge aluminum alloy case is made for rough usage, with leather grip handle and steel padlock hasp.—*Scott-Rice Co.*, 610 *S. Main, Tulsa, Okla.*

For more information circle **160** on inquiry card.

FOUR INPUTS TO ONE SCOPE

New Type ES-141 Multi-channel Electronic Switch accepts four or more independent signals and se-

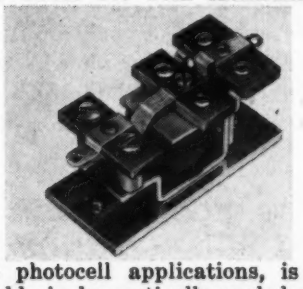


quentially connects them for a 4-way display on one oscilloscope. Cycles at 500 kc, permitting 2 μsec per position. Basic model is 4-channel but can be adapted to any number of positions limited only by the total sampling time available. New data sheet is available on request.—*The Newton Co., Manchester, Conn.*

For more information circle **161** on inquiry card.

POWER RELAY

New Series 261 power relay capable of direct use with cadmium sul-

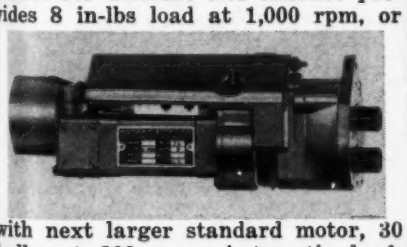


phide photocell applications, is also available in hermetically sealed units meeting MIL-R-5757C. SPDT contacts are rated at 20 amps; coils are available to 15,000 ohms, ac or dc.—*Kurman Electric Co. Div., Norbute Corp.*, 191 *Newel St., Brooklyn* 22, *N. Y.*

For more information circle **162** on inquiry card.

COMPACT ROTARY ACTUATOR

New Model D-1900 rotary actuator with dual counter-rotating output shafts for aircraft and missiles provides 8 in-lbs load at 1,000 rpm, or

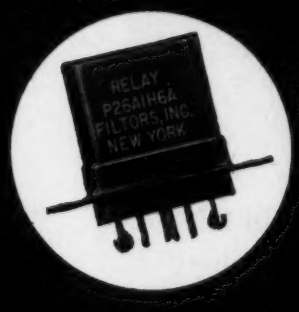


with next larger standard motor, 30 in-lbs at 200 rpm. Automatic load-sensing and travel-limiting device automatically stops and holds a predetermined load, adjustable from 6 in-lbs to 17 in-lbs. Radio noise filter, integral thermal protector, and electromechanical clutch-brake are also included. Motors for 26 v dc, 400 cycle, single or polyphase, or other dc voltages are available.—*Hoover Electric Co., Hangar Two, Port Columbus Airport, Columbus* 19, *Ohio*

For more information circle **163** on inquiry card.

Circle **39** on inquiry card. ⟶

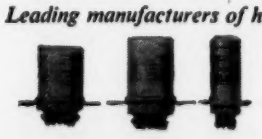
FILTORS NEW MICRO-MINIATURE...THE MOST ADVANCED DESIGN



Filtors, the leading specialists in the development and manufacture of sub-miniature relays is proud to announce the addition of the new Powrmite micro-miniature relay to its existing line of traditionally outstanding relays.

In every field of achievement there is always one leader. In relays with highest available reliability the leader is Filtors, Incorporated. All of the experience and know how gained in attaining its position of leadership have gone into making Filtors new Powrmite micro-miniature relay *truly reliable*—again the leader in a field of many.

Leading manufacturers of hermetically sealed micro and sub-miniature relays.



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VIBRATION UP TO 30 G's AT 2000 CPS.
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MINIATURE ROTARY SWITCH

New MA-12 miniature rotary switch meeting MIL-S-3786 provides 30° indexing, 12 contact positions, up to 5 sections, with current-carrying capacity of 3 amp. Interrupting capacity is ½ amp, 115 v ac. Can be furnished with up to six poles per section and in unlimited rotation or limited from 2 to 12 positions.—*R-F Electronics, Inc., Div. Electro Switch Corp., Weymouth 88, Mass.*

For more information circle **164** on inquiry card.

RELAY-CONNECTOR UNIT

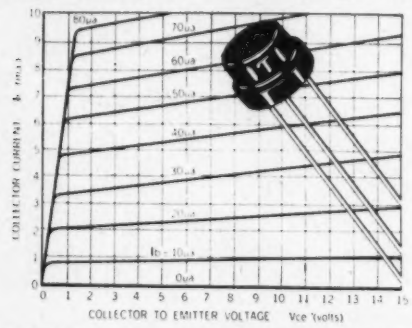
New AL-AN series of hermetically sealed, rotary balanced-action relays

with integral AN connector, has been tested for impact shocks up to 1,000 G and is available in ac and dc versions up to 4PDT, 10 amp contacts, for a wide range of voltages. Additional data on request.—*Hi-G, Inc., Bradley Field, Windsor Locks, Conn.*

For more information circle **165** on inquiry card.

HIGH-BETA SILICON TRANSISTOR

New types 2N543, 2N542 and 2N-541 operate at 45, 30 and 15 volts resp., with minimum current gain of



80. Useful beta is also maintained at reduced collector current levels and over temperatures from −65° to 150° C. Full information in brochure TE-1353 on request.—*Transitron Electronic Corp., Wakefield, Mass.*

For more information circle **166** on inquiry card.

EPOXY MOLDED TOROIDS

Custom production and engineering assistance on toroidal chokes, toroidal transformers and special universal coils for military applications is now available to manufacturers of filters, communications equipment and transistor power supplies. Pilot models or production runs can be delivered. —*A. W. Welch Mfg. Co., Inc., 509 E. 29 St., Indianapolis 5, Ind.*

For more information circle **167** on inquiry card.

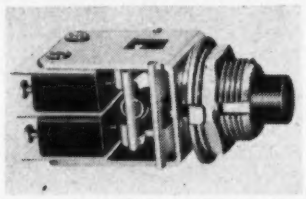
POWER TRANSISTORS

Four new germanium PNP transistors for switching, power conversion, voltage regulation and other high current applications are designated CTP 1511, CTP 1512, CTP 1513 and CTP 1514; with collector-to-base breakdown voltages of 100, 80, 60 and 40 v dc respectively. Max ratings are 13 amp collector current, 90° C junction temperature, and total power dissipation of 20 watts at 70°C mounting base temperature.—*Clevite Transistor Prod. Div., Clevite Corp., Waltham, Mass.*

For more information circle **168** on inquiry card.

MOMENTARY ACTUATOR

New type A4-86 actuator for momentary, positive-feel push-button application, uses Electrosnap F4—100 series subminiature basic switches to

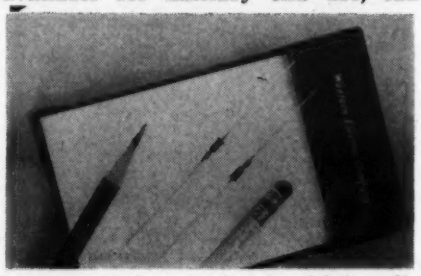


provide two SPDT contacts for 150,-000 operations @ 125/250 v ac, 2.5 amps or 50,000 operations @ 30 v dc 4 amps resistive.—*Electrosnap Corp., Switch Div., 4230 Lake St., Chicago 24, Ill.*

For more information circle **169** on inquiry card.

SILICON DIODE

New subminiature diffused junction silicon diode, 1N673, immediately available for military end use, can



be connected in series for high voltage without use of paralleling resistors. Peak forward current to 3 amp, piv of 350 v, less than 1.0 μamp at 300 inverse volts, and max power dissipation of 250 mw at 25°C are characteristics.—*Radio Div., Western Electric Co., 120 Broadway, New York 7, N. Y.*

For more information circle **170** on inquiry card.

HI-CAPACITY MINIATURE SWITCH

New Type 16 Subminiature switch uses doublebreak contacts to provide 10 amp 30 vdc capacity in a body only ¼" x $\frac{7}{16}$" x 25/32", achieving a life of 20 million operations. Three terminal styles and a variety of activators are available.—*Licon Switch Div., Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.*

For more information circle **171** on inquiry card.

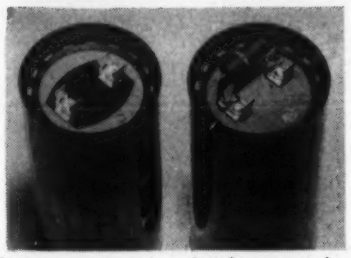
TUBULAR CAPACITORS

New Mylar-Polystyrene, Teflon, and metalized Mylar capacitors said to be especially designed for applications in computers, servomechanisms, avionics and guided missiles are available in sizes from 0.001 to 10.0 uf. Catalog availble on request.—*Condenser Research Corp., P. O. Box 161, Seymour, Ind.*

For more information circle **172** on inquiry card.

"PRINTED RESISTOR" CAPACITORS

New printed resistors integral with capacitor terminals eliminate soldered

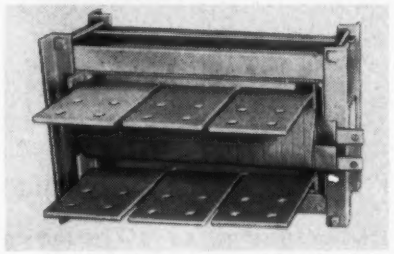


resistors, prevent point burnout in relays and bleed off stored charges. Capacities and resistance values available on request.—*Aerovox Corp., New Bedford, Mass.*

For more information circle **173** on inquiry card.

SPECIAL PURPOSE TRANSFORMERS

Custom design facilities for special transformers are illustrated by 30 kva, 240 v input; 10v-3000 amp out-



put divided into three identical but isolated secondaries. Each transformer must individually meet customer's requirements for core loss, polarity, voltage, corona, insulation breakdown and aging characteristics before shipment.—*Nothelfer Winding Labs., Inc., P.O. Box 455, Trenton, N. J.*

For more information circle **174** on inquiry card.

RE-USABLE CELL HAS LONG WET-STAND LIFE

New PM Silvercel primary battery is ready for immediate use upon filling but can stand for months without loss of capacity after activation. Because it can be re-used, it can be checked for reliability by discharging it prior to use then reactivating it. Shown in single and multicell forms, the PM Silvercel is capable of energy outputs as high as 70 watt-hr/lb.—*Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y.*

For more information circle **175** on inquiry card.

Luneberg Lens Reflector

The Ecco Luneberg Lens is a variable dielectric-constant device of special contour which focuses an incident plane electromagnetic energy wave to a point on its surface, or conversely produces a plane wave from a point source. There are many unique applications for the Ecco Luneberg lens; one important application is rapid wide angle scanning of a radiation beam by moving a small feed over the surface of the stationary lens; another is an efficient electromagnetic energy reflector (Fig. 1).

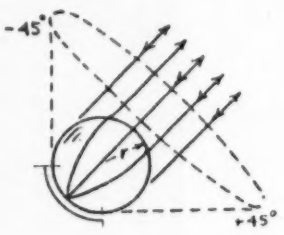


FIG. 1. PLASTIC FOAM reflector uses Luneberg Lens principle to provide eight times reflectivity of corner reflector.

The Ecco reflector is effective as a passive target for radar energy. Energy incident on the Luneberg lens is focused and re-radiated in the direction from which it originated. Similar in action to a corner reflector, it is far superior to the corner reflector for wide angle coverage; it has a radar cross section approximately eight times that of a circular corner reflector of the same radius.

TABLE I. EFFECTIVE ECCO REFLECTOR CROSS SECTION

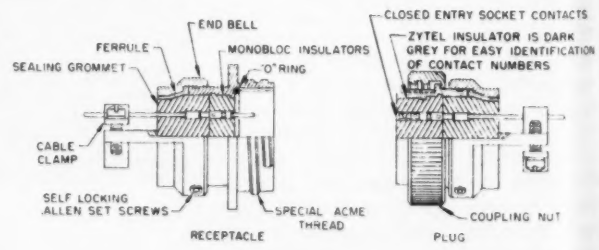
Lens Diameter (inches)	Radar Cross Section X Band (3.2 cm) (sq-ft)	S Band (10.0 cm) (sq-ft)	Weight (lbs)
7	81		2.6
12	700	70	10.5
18	3,500	360	38.0
36	56,000	5,800	295.0

(*From Technical Bulletins 6-2-3 and 6-2-3A, Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.*)

For more information circle **176** on inquiry card.

Environment Resisting Connectors

The new KM series of miniature connectors meeting Mil-C-25955 (USAF), consists of class E (environment resisting), and a class H (hermetically sealed,



mating receptacles to the class E). The class E connector (Illustrated) features: "O" ring seals and moisture sealing grommets resist environment without pot-

ting, snap-in solderless contacts are field removable with simple tool, KM's are interchangeable and will mate with existing Cannon KO miniatures, and accommodate #20 through #26 AWG and RG-179-U miniature coaxial cables.

Class H (Hermetic) connectors contain pin contacts only, fused in a vitreous insulator fused to the shell. This creates a connector seal that will prevent a leakage rate in excess of one micron cu-ft per hr, as tested on a mass spectrometer, at a pressure differential of 15.5 psig. Cannon hermetically sealed connectors will operate up to 450°F; or, with special plating, to 1000°F.—(*From 12-page catalog KM-1, Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.*)

For more information circle **177** on inquiry card.

"How to Make" a Predesigned Mechanism

A complete 2⅞" dia servo mechanism can be assembled from standard PMC components in accordance with your schematic sketch. Maximum standard capacity, 6 synchro style components; standard gear reductions to a maximum ratio of 75,125: 1. Assembly steps (for numbers in parens, see Fig. 1) are:

Assemble a basic gear Unit from Gear Plate Assembly (11), Shafts (5), and Clamp-on Gears (1).

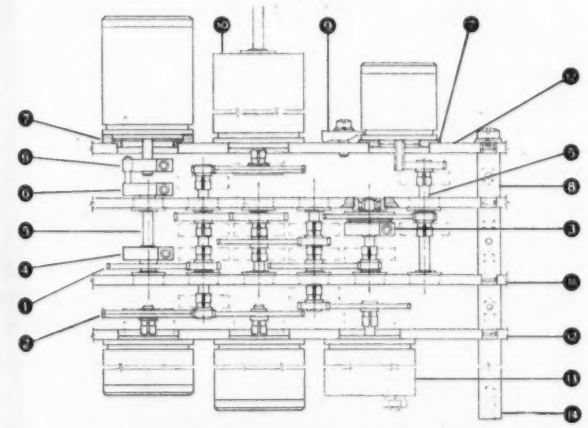


FIG. 1. "UNWRAPPED VIEW" of typical servomechanism.

Attach a Component Mounting Plate (12) to one or both sides of the gear unit.

Mount and interconnect the synchro style components with Pin Couplings (6) or Gears (1).

Use Pilot Adapter Rings (7), Anti Backlash Gears (2), and Slip Clutches (3), as required.

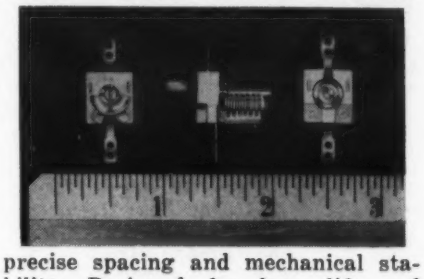
Standard adjunct apparatus includes infinitely adjustable Limit Stops (13), Shaft Take-Off Assemblies (10), Mounting Bases, Brackets, and Legs (14).

No guesswork; assembly is automatic and free of interference when gears are butted against shaft retainer rings with hubs positioned as in the "unwrapped view." Gears are supplied in pairs totaling 132 teeth as required by the standard fixed shaft centers. Mechanisms can also be supplied completely assembled.—(*From six-page brochure "Predesigned Mechanisms & Components," Precision Mechanisms Corp., 577 Newbridge Ave., East Meadow, L. I., N. Y.*)

For more information circle **178** on inquiry card.

RUGGED AIR VARIABLE CAPACITOR

New Type "U" sub-miniature air variable capacitor has rotor and stator machined from solid brass for

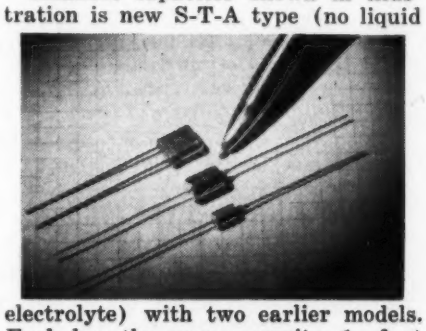


precise spacing and mechanical stability. Designed for long life and freedom from moisture entrapment found in trimmer capacitors of enclosed or solid dielectric type. Data Sheet #756 on request.—*E. F. Johnson Co., Waseca, Minn.*

For more information circle **179** on inquiry card.

SOLID TANTALUM MICRO CAPACITOR

Smallest capacitor shown in illustration is new S-T-A type (no liquid



electrolyte) with two earlier models. Each has the same capacity, 1 μf at 35 wvdc. Leakage and dissipation factor are also improved.—*Fansteel Metallurgical Corp., No. Chicago, Ill.*

For more information circle **180** on inquiry card.

MINIATURIZED H-V SUPPLIES

New HYPAC units provide high voltage with regulated outputs for CRTs, Klystron, travelling-wave tubes and radiac equipment by using solid

state and magnetic amplifier circuitry. Designed either for ac or dc inputs, ac is first converted to dc, then chopped with transistor keyers and re-converted into a high-frequency, high-voltage square wave. Magnetic and related components are encapsulated while semiconductors are replaceable for servicing and testing within the transformer type housing.—*Era Pacific, Inc., 1760 Stanford St., Santa Monica, Calif.*

For more information circle **181** on inquiry card.

TRIGGER UNIT FOR NEW SOLIDSTATE "THYRATRONS"

New Fairfield MRC Magnetic Rectifier Control for driving the new GE ZJ-39A controlled silicon rectifier equivalent of the Thyratron, provides higher efficiency and faster response,

with less size and weight, than previously required by magnetically-controlled thyratron (MTC) units. MRC units and silicon controlled rectifiers meet applicable Mil Specs, are available in models from small half-wave single-phase to 30 kw 3-phase power servos for military and industrial use. MRC's steep wavefronts reliably trigger silicon rectifiers despite variations in rectifier characteristics; are provided in 60 and 400 cps models.—*Fairfield Eng. Corp., 934 Hope St., Springdale, Conn.*

For more information circle **182** on inquiry card.

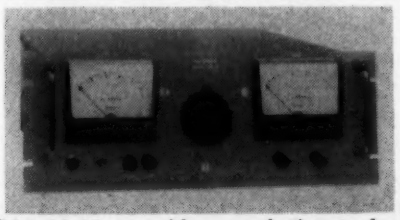
VARIABLE FREQUENCY SUPPLIES

Power for testing equipment requiring variable frequencies or power of single frequency other than line frequency, is available from new power supplies VP-410 and VP-1000 (400 VA and 1000VA respectively). Both units operate from 115 v, 50-60 cps source to give variable voltage and frequency outputs from 75 to 150 v, 47 to 6000 cps. Other characteristics are described in bulletin VP-858, available on request.—*Empire Devices Products Corp., Amsterdam, N. Y.*

For more information circle **183** on inquiry card.

STRAIN GAGE POWER

Chopper stabilization in new transistorized power supply, Model HY-



CA1-10-10, provides regulation to less than 1 mv for all combinations of line and load variation and voltage setting. Temp coefficient is less than 0.0025%/°C from 5° to 45°C ambient. Input 105-125 v ac; output 1 to 10 v dc, 10 amp.—*Hyperion, Inc., West Newton, Mass.*

For more information circle **184** on inquiry card.

Dorne & Margolin has designed more antennas for more different missiles and aircraft than any other company in the nation.

WRITE FOR CATALOG
DORNE & MARGOLIN, INC.
29 New York Ave., Westbury, N. Y.
West: 1434 Westwood Blvd.
Los Angeles 24, Cal.

For more information circle **40** on inquiry card.

PROTECTED REGULATED SUPPLY

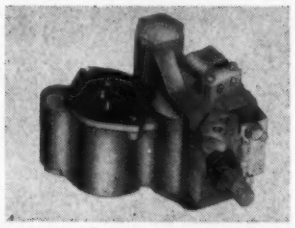
New Model 1515 transistorized power supply is protected by ROBOTEC circuit which operates in 30 μsec to produce simultaneous current and

voltage cutoff with an external short circuit. The power supply is held cut off until manually reset; cannot be turned on if short circuit persists. Output is 1-15 volts d-c continuously variable at 0-1.5 amperes; regulation better than 15 mv or 0.05%; ripple is less than 250 μv source impedance is 0.01 ohms and response time less than 50 μsec. Input: 105-125 volts, 55-440 cps.—*Power Designs Inc.*, 89-25 130*th St.*, *Richmond Hill* 18, *N. Y.*

For more information circle **185** on inquiry card.

HYDRAULIC POWER UNIT

New auxiliary power unit for missile control uses 12,000 rpm shaft input to provide hydraulic oil pres-



sure output of 0.6 gpm against 2,000 psi. Squib-actuated load valve bypasses turbine to permit rapid acceleration after startup until auxiliary power is required, when electrical signal fires squib to close valve.—*Eastern Industries, Inc.*, 100 *Skiff St.*, *Hamden, Conn.*

For more information circle **186** on inquiry card.

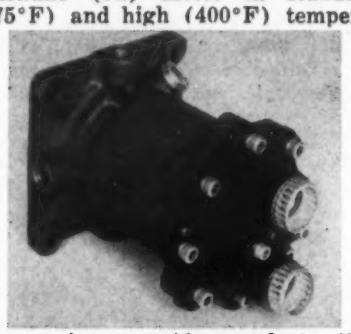
THIN DATA CAMERA

New Thinform Model FDTF-001 16mm motion picture camera, only 1¼" thick is specifically designed for flight research installations in airfoils, missiles, etc. Uses intermittent film transport at speeds from 16 to 64 frames/sec, changed by gear set substitution. Environmentally tested to operate to 25 G on three axes, vibration to 500 cps at 10 G, temperatures from −65° to 150°F. —*Fairchild Data Devices Corp.*, 580 *Midland Ave.*, *Yonkers, N. Y.*

For more information circle **187** on inquiry card.

HYDRAULIC SERVO MOTOR

New Type 53 Stratopower 5¾ lb hydraulic (oil) motor in standard (275°F) and high (400°F) tempera-

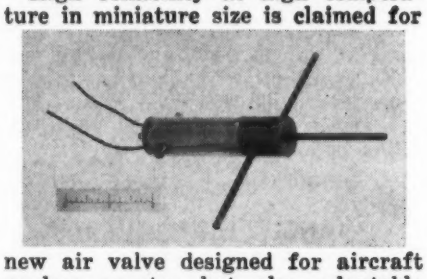


ture versions provide speeds to 4500 rpm at torque efficiencies of 93%. High speed version attains 6400 rpm. New hydraulic motors are said to feature low moment of inertia, low friction and fast response rates in servo systems.—*Watertown Div., New York Air Brake Co., Watertown, N.Y.*

For more information circle **188** on inquiry card.

SOLENOID PNEUMATIC VALVE

High reliability at high temperature in miniature size is claimed for



new air valve designed for aircraft nuclear reactor but also adaptable to other liquids and gasses. Has passed life tests in 500°F ambients, also Mil-Spec requirements.—*Alco Valve Co.*, 865 *Kingsland Ave.*, *St. Louis* 5, *Mo.*

For moer information circle **189** on inquiry card.

PNEUMATIC PROTECTOR

New low-pressure-range GageGard Jr. affords positive protection to incline manometers, draft gages, and

other sensitive low-pressure transducers. For either atmospheric or relative pressure systems, it will reopen after sealing at 2% below cutoff point, which can be adjusted at will. Covers span from −15 psig to 85 psig in four ranges. 2-page bulletin 547G covers complete specifications.—*Industrial Eng. Corp.*, 525 *E. Woodbine, Louisville, Ky.*

For more information circle **190** on inquiry card.

CRYOGENIC VALVES

New gate valves for LOX and other cryogenics for line pressures up to 60 psi and ambient temperatures from −320° to 250°F, are available for manual, hydraulic, electrical or pneumatic operation. Also can be used for handling of standard aircraft and missile fuels and oxidizers. —*Koehler Aircraft Products Co.*, 409 *Leo St.*, *Dayton* 4, *Ohio.*

For more information circle **191** on inquiry card.

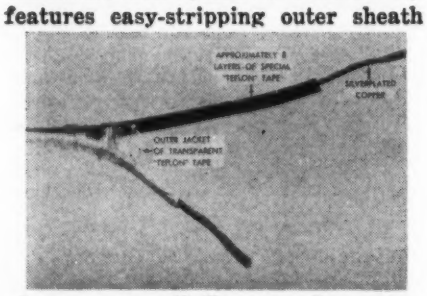
HYDRAULIC FAILURES FILTERED OUT

Millipore laboratory analyses of hydraulic fluids under provisions of Military Specifications have shown particulate contamination to be a major cause of servo valve failure. Large-scale filtration equipment using *Microweb*, a monofilament nylon reinforced form of Millipore Filter, is now available for cleaning aircraft hydraulic fluids to 0.45 microns. Microweb filters with capacities to 45 gpm are said to be already in service for handling incoming oils, on fill/flush/bleed stands, in missile field test installations, for component flushing and in recirculation of ultrasonic fluids.—*Millipore Filter Corp.*, 36 *Pleasant St.*, *Watertown* 72, *Mass.*

For more information circle **192** on inquiry card.

"RIP-CORD" TYPE CABLE

New 250°C 2-conductor flexible miniature cable (sizes 20 to 32 AWG) features easy-stripping outer sheath



of transparent Teflon tape. Inner conductors with Flexolon longitudinal tape insulation have more flexibility and dielectric strength, are easily identified through outer sheath.—*Tensolite Insulated Wire Co., Inc., W. Main St., Tarrytown, N. Y.*

For more information circle **193** on inquiry card.

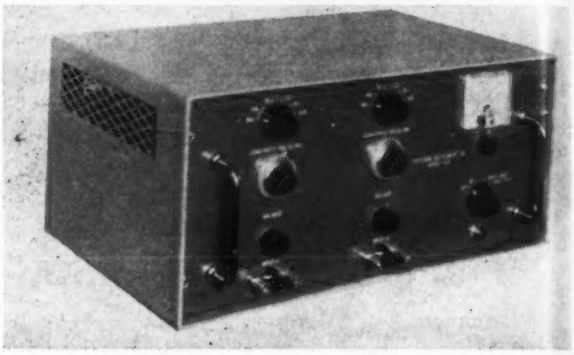
OXYGEN-FREE COPPER FOR HIGH TEMPERATURE CABLES

Oxygen-free, high-conductivity 99.-99% pure copper is used exclusively and at no increase in price in aeromarine teflon-insulated cables and wire. Absence of extraneous inclusions is said to improve ductility, provide higher electrical and thermal conductivity, and to lower deterioration when heated; all important characteristics for wire used in high temperatures.—*Aero-Marine Development Corp.*, 110 *Summit Ave.*, *Chatham, N. J.*

For more information circle **194** on inquiry card.

Oscillograph Amplifier Doubles as Lab Amplifier

Dual-channel dc amplifiers, Models D3 and D5, utilize two individual plug-in amplifier strips and one voltage regulator strip. Model D3 can be used with direct writing oscillographs or for general laboratory work. Model D5 is a tri-purpose amplifier for driving

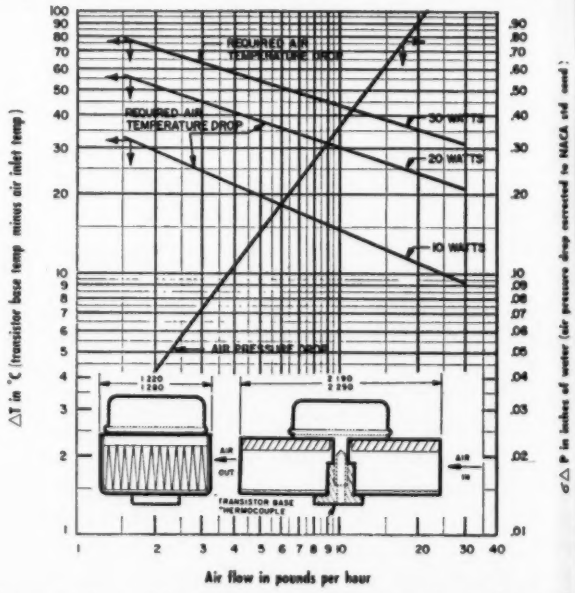


mirror-type or direct writing galvanometers as well as a general purpose instrument. Both amplifiers provide gain to 1000, are flat for pen galvanometer frequencies from 0 to 100 cps, have drift less than 1 mv/hr, less than 7° phase shift at 2000 cps, and supply outputs to ±30 v into outputs of approx. 50 ohms impedance. Housed in steel cases for portable use the amplifiers can be removed for installation in a standard 22" rack.—(*From new 8-page oscillograph and amplifier catalog, Photron Inst., Co.*, 6516 *Detroit Ave.*, *Cleveland* 2, *Ohio.*)

For more information circle **195** on inquiry card.

Transistor Cold Plates

UAP No. U-522600 Aluminum Cold Plate for a specific transistor accepts 7 lbs air/hr at a pressure drop of 0.25" water to dissipate 1.5° per watt tran-


REQUIRED AIR TEMPERATURE DROP
REQUIRED AIR TEMPERATURE DROP
30 WATTS
20 WATTS
10 WATTS
AIR PRESSURE DROP
ΔT in °C (transistor base temp minus air inlet temp)
ΔP in inches of water (air pressure drop corrected to NACA std cond)
Air flow in pounds per hour
AIR OUT
AIR IN
TRANSISTOR BASE THERMOCOUPLE

sistor rating. Air pressure and temperature drops for other values of air flow are shown in the curve.

Heat travels by conduction through the mount into the extended surface fins through which cooling air flows. The fins are integrally brazed to the mounting

surface, or cold plate, which is sized and matched with the available cooling air supply to control the transistor junction temperature within operating limits. The cooling air can be ducted from an aircraft circulating air system, an air cycle refrigerating system, a ram air supply, etc. Besides a family of single transistor cold plates, other cold plates to accommodate up to 30 or more transistors are available. (*From 2-page data sheet on Transistor Cold Plates, United Aircraft Products, Inc.* 1116 *Bolander Ave., Dayton, Ohio.*)

For more information circle **196** on inquiry card.

Elevated Flooring Gives Access To Computer Facilities

Large electronic computer installations require long cable runs, complicated cable connections, air conditioning ducts, air lines, vacuum lines, chilled water piping, underfloor plenum chambers and relocation of electric wiring and telephone lines, etc. The ideal solution—prescribed by the manufacturers of electronic computers—is a strong raised floor with removable panels, under which the cables, ducts, piping, etc., can travel in any direction and yet be instantly available.

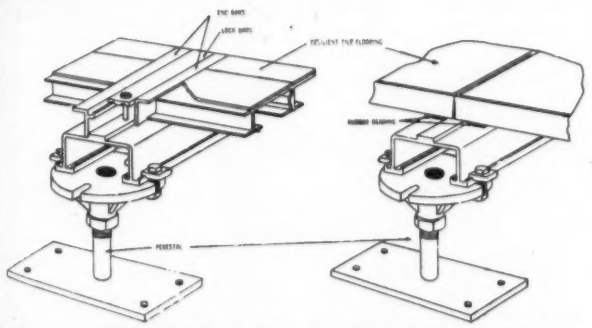


FIG. 1. **LOCKING** (left) and Non-locking (right) types of Elaflor provide underfloor access space for computers and other electrical installations.

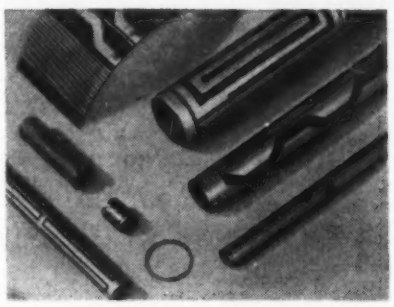
Elaflor (Elevated Aluminum Flooring) panels, available in a wide choice of sizes, are fabricated of internally stiffened aluminum tongue-and-groove planks, 6″ in width, surfaced with Vinyl tile or carpeting. Clearance for underfloor facilities is governed by the height of steel supporting pedestals which are adjustable to allow for any unevenness in the existing floor. Openings for cable access and air conditioning ducts are supplied cut to fit the equipment layout, and the Vinyl-surfaced panels are quickly removable for access to any underfloor space. Elaflor panels are available in either the locking or the non-locking type (Fig. 1).

Any competent building contractor can install Elaflor, which is individually planned and shipped complete with all components to meet the customer's installation requirements. The finished floor is capable of sustaining a load of 200 lbs/sq-ft, and a 1000 lb concentrated load, yet it adds only 6 lbs/sq-ft dead weight to the existing floor load. (*From 8-page illustrated brochure, Liskey Aluminum, Inc.,* 1405 *Rome Rd., Baltimore* 27, *Md.*)

For more information circle **197** on inquiry card.

TUBULAR PRINTED CIRCUITS

Direct printing of solderable silver circuits on the exterior, interior, or both surfaces of non-conducting tubular materials having I. D. as small as ½″ for instrument housings, capacitance type fuel gages, resistors, heaters, probes, microwave parts, etc., is being accomplished to customer's requirements.—*J. Frank Motson Co., Flourtown, Pa.*



For more information circle **198** on inquiry card.

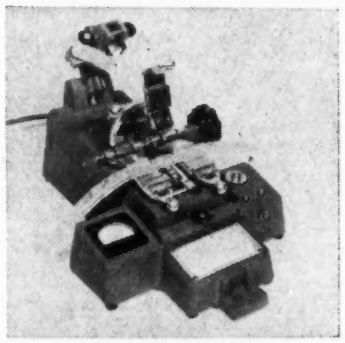
CUSTOM FABRICATED CASES

New line of "Warlite" plastic-impregnated wood cases have high temperature, moisture and warping. Cases fabricated to customer's needs meet military specifications, on pilot or production runs.—*Warwick Products Co.,* 1575 *Riverbed Rd., Cleveland* 13, *Ohio.*

For more information circle **199** on inquiry card.

UNIVERSAL TAPE SPLICER

Magnetic and paper tapes, either butt-welded or overlapped, are spliced in 2 seconds with new Model 400.5



Combination Splicer using no cement or adhesives. Tapes from ½″ to 1¼″ width are accommodated, using separate welding heads for paper and magnetic tape. Only 30 seconds required to change heads, no tools are needed.—*Prestoseal Mfg. Corp.,* 37-27 33*rd St., Long Island City* 1, *N. Y.*

For more information circle **200** on inquiry card.

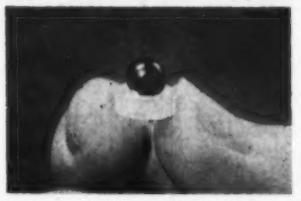
STABILIZER CHASSIS MOUNT

New all-metal stabilizer unit limits sway space but permits freedom of motion in vertical dimension. Characteristics are described and other mounts and bases listed in new 4-page catalog available on request.—*K. W. Johnson & Co., Inc.,* 1825 *Webster St., Dayton* 4, *Ohio.*

For more information circle **201** on inquiry card.

SAPPHIRE VALVE BALL

Space Vehicle relief valve, built by Whittaker Controls Div., Telecomputing Corp., uses Linde Sapphire ball



to maintain helium leak-tight operation and withstand severe shocks, scratching and erosion despite great temperature changes. Sapphire is chemically inert, can be used in hot gas or hot acid valves; is also specified in infrared optical systems, microwave windows, and radomes to 4½″ dia.—*Crystal Prod. Dept., Linde Co.,* 30 *East* 42 *St., New York* 17, *N. Y.*

For more information circle **202** on inquiry card.

SPLIT-FLAPPER CHECK VALVE

New check valve design with twin flappers opening in direction of normal flow is said to promote exceptionally clean flow and is adaptable in varied materials for all types of liquids and gases, and from cryogenic to 1000°F temperatures. Light and compact construction makes the unit ideal for missile fueling trailers, etc. —*AiResearch Industrial Div., The Garrett Corp.,* 9851 *Sepulveda Blvd., Los Angeles* 45, *Calif.*

For more information circle **203** on inquiry card.

INTERCHANGEABLE LENS MAGNIFIER

New Rocket Viewer includes three unbreakable snap-in lens sets of increasing power. Pliable head-set is light in weight, adjustable to head size and can be worn over eye glasses.—*Standard Unbreakable Watch Crystals, Inc., New York* 51, *N. Y.*

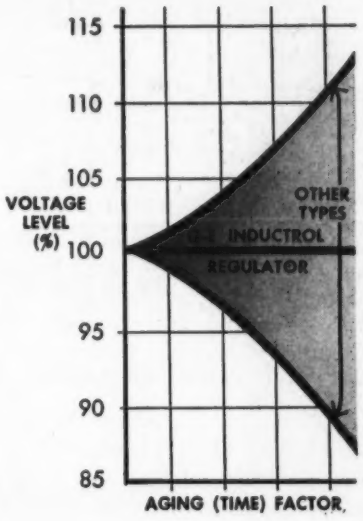
For more information circle **204** on inquiry card.

SPECIAL OPTICS AND COATINGS

Precision lenses, IRdomes, windows, prisms and complete sub-assemblies are produced from raw glass and vacuum-coated to customer or Govt. formulas and specifications. New vacuum coating department applies antireflective magnesium fluoride, aluminum with fluoride or quartz protective overcoatings, also dichroic and electrically conductive coatings including copper, silver and gold.—*Zenith Optical Laboratory, Copiague, L. I., N. Y.*

For more information circle **205** on inquiry card.

NO DRIFT PROBLEM



You get . . . Assured Accuracy From G-E Inductrol* Voltage Regulators

With the G-E Inductrol regulator control, voltage is automatically held to within ±1% bandwidth. Unique compensating controls on the G-E Inductrol regulator make it unnecessary to continually reset voltage level. You merely set it at the desired voltage level, and forget it. This highly reliable and accurate automatic control is also compensated for temperature, and is inherently insensitive to frequency or power factor changes.

For more information write Section 425-12, General Electric Co., Schenectady, N. Y.

*Registered trademark of General Electric Company for Induction Voltage Regulators

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle **41** on inquiry card.

New Magnetic Amplifiers Are Interchangeable

New high precision Acromagmagnetic amplifiers use matched tape-wound toroidal cores, precision resistors and silicon rectifiers to achieve a high degree of standardization, reliability and life expectancy equivalent to that of a well-made transformer. Units of the same type may be interchanged.

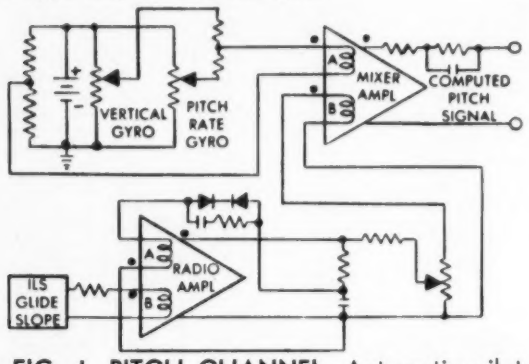


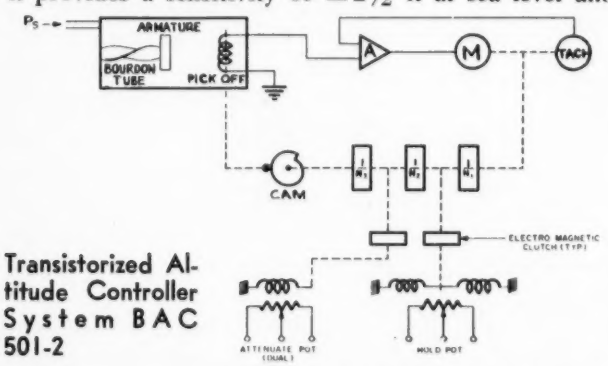
FIG. 1. PITCH CHANNEL, Automatic pilot

Applications are found in missile guidance, automatic pilots, (Fig. 1) monitoring systems, helicopter speed controls, nuclear measurements, automatic tape transports, and electro-hydraulic valves drives. Hermetically sealed, 3″ high x 1½″ dia plugin unit uses 3 va, 400 cps power 115 v.—(*From 4-page bulletin No. 401A, Acromag, Inc.*, 22519 *Telegraph Rd., Detroit* 41, *Mich.*)

For more information circle **206** on inquiry card.

Servomechanism Controls Altitude

Automatic Altitude Control for use with autopilot for constant barometric altitude flight operations and for use with automatic landing systems has been developed to operate directly from the plane's 28v dc power supply. Designated the SMI Type BAC 501-2, it provides a sensitivity of ±2½ ft at sea level and



Transistorized Altitude Controller System BAC 501-2

operates from minus 1000 to plus 60,000 ft altitude. In operation a twisted bourdon tube, linear with pressure is nulled with changing pressures by means of a motor and gear train. Gear-train motion is linear with altitude, thus any point on the train may be used for positioning a synchro to reflect changes in altitude. Utilizing transistors, the design meets Mil-E-5400, weighs only 9 lbs.—(*From 2-page technical brochure, BAC* 501-2, *Servomechanisms, Inc.*, 12500 *Aviation Blvd., Hawthorne, Calif.*)

For more information circle **207** on inquiry card.

MA New Literature

ELECTRONIC OPTICAL Tracking System (EOTS) equipment comprising photo-theodolites, controls, master station synchronization and radar slaving equipment, with accessories, is described in 12-page booklet by Contraves AG, Zurich.—J. W. Fecker, Inc., 6592 Hamilton Ave., Pittsburgh 6, Pa.

For more information circle **208** on inquiry card.

LEAD-SULFIDE PHOTOCONDUCTOR performance characteristics, with particular attention to production of Infratron detectors and control resistance, time-constant, responsivity, S/N and stability under environmental conditions are given in new 8-page report.—Infrared Industries, Inc., 163 Highland Ave., Needham Heights 94, Mass.

For more information circle **209** on inquiry card.

SUBCARRIER SIGNAL ANALYZER for voltage measurement on separate telemetering or communication subcarrier channel signals is described in 2-page bulletin.—Rycom Instruments Div., Railway Communications, Inc., 9351 E. 59th St., Raytown 33, Mo.

For more information circle **210** on inquiry card.

MINI PRECISION RESISTORS using new materials, new designs, are detailed with specs in new 4-page Series 77 Metal Film Resistor bulletin.—Ohmite Mfg. Co., 3696 W. Howard St., Skokie, Ill.

For more information circle **211** on inquiry card.

OSCILLOSCOPES and accessories including new photo-recording attachments which permit single or cine-type exposures are listed with technical descriptions in new 12-page catalog.—Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

For more information circle **212** on inquiry card.

DELAY LINES, construction and figure of merit parameters for DYKOR lumped constant and continuously variable delay lines are described in new catalog DL-78.—Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y.

For more information circle **213** on inquiry card.

PRESSURE TRANSDUCERS, accelerometers and miniaturized, transistorized carrier amplifiers are featured in pack of eight 2-page brochures.—Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

For more information circle **214** on inquiry card.

MACH CHARTS, one comparing Mach number with Altitude; the second showing relationship of Mach number and Temperature are free on request to interested engineers.—G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

For more information circle **215** on inquiry card.

UTILITY PACKAGED AMPLIFIER for computer applications and laboratory instrumentation is explained with application and engineering parameters in new 16-page Tentative data booklet UPA-2.—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

For more information circle **216** on inquiry card.

METER-RELAYS (Sensitivities from 0.2 μamp to 10 amp) are described with circuitry in new 16-page bulletin 104-C. Standard and special cycling, reset, and multiple-relay circuits are covered.—Assembly Products, Inc., 75 Wilson Mills Rd., Chesterland, Ohio.

For more information circle **217** on inquiry card.

ABSORPTION ANALYZER test instruments for communications and other tuned electronic-channel troubleshooting, pick up signals and waveforms electrostatically over the 3 to 240 mc range. Equipment said to avoid loading circuit under test, is described in 10-page catalog—Kingston Electronic Corp., Medfield, Mass.

For more information circle **218** on inquiry card.

SERVOMOTOR-RATE GENERATOR, size 8, Model 18MG 420/410 producing acceleration at stall of 110,000 rad/sec², is described in new 4-page bulletin No. 1402.—Beckman/Helipot Corp., Newport Beach, Calif.

For more information circle **219** on inquiry card.

JET EXHAUST TEMPERATURE indicator for airborne and missile test-stand applications with less than 1°C error in the 500° to 1000° range is described in new 4-page bulletin, "BH-183 AutoTemp".—B&H Instrument Co., Inc., 3479 W. Vickery Blvd., Ft. Worth 7, Tex.

For more information circle **220** on inquiry card.

MOTOR-STARTING relay, current-type for split-phase or capacitor-start motors instead of centrifugal switches are described in new 4-page bulletin STR-3.—Spencer Div., Metals & Controls Corp., Attleboro, Mass.

For more information circle **221** on inquiry card.

RF COILS, with adjustable tuning and planned for Automated assembly in printed circuits, are described in 2-page catalog sheet.—Essex Electronics, 550 Springfield Ave., Berkeley Heights, N. J.

For more information circle **222** on inquiry card.

HYDRAULIC, FUEL and pneumatic solenoid valves with "straight-through" flow design and meeting applicable Mil-Specs for missile use are described in new 8-page technical brochure.—Valcor Engineering Corp., 5365 Carnegie Ave., Kenilworth, N. J.

For more information circle **223** on inquiry card.

HYDRAULIC FILTERS for servos, gyro systems, cooling systems and ultrasonic cleaning are described in new 16-page MF 1958 Supplement.—Millipore Filter Corp., 36 Pleasant St., Watertown 72, Mass.

For more information circle **224** on inquiry card.

AMPLIFIER. 2-page Technical Data Sheet on S3100-01 dual channel transistorized buffer amplifier.—Kearfott Co. Inc., 1378 Main Ave., Clifton, N. J.

For more information circle **225** on inquiry card.

HIGH VACUUM equipment for semiconductor production and hermetic sealing of components is described in new 4-page bulletin.—Kinney Mfg. Div., The New York Air Brake Co., 3529 Washington St., Boston 30, Mass.

For more information circle **226** on inquiry card.

ULTRASONIC LIQUID LEVEL sensing system applicable to aircraft, missile and reactor applications and meeting Mil-Specs for exotic, inflammable and cryogenic liquids is described in new 4-page brochure.—Acoustica Associates, Inc., 26 Windsor Ave., Mineola, N. Y.

For more information circle **227** on inquiry card.

MISSILE and Aircraft airvalves and actuators, temperature control and positioning systems are described in new 4-page brochure F 5910-1.—Barber-Colman Co., 1400 Rock St., Rockford, Ill.

For more information circle **228** on inquiry card.

EQUIPMENT COOLING Aximax-3 fan (165 CFM) is described in new engineering catalog sheet (50201-3A) with mounting features and performance curves.—Rotron Mfg. Co., Schoonmaker Lane, Woodstock, N. Y.

For more information circle **229** on inquiry card.

MINIATURE SWITCH. New 2-page Data Sheet 148 describes new subminiature size precision, snap-action switch.—Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

For more information circle **230** on inquiry card.

STATIC FLASHERS for lamp loads to 1.5 amp, using transistorized circuit, no moving contacts, are explained for missile applications in new 4-page bulletin.—Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif.

For more information circle **231** on inquiry card.

CLEANING SOLUTIONS, various solvents are compared with "Freon" compounds as to toxicity, flammability, degreasing action and effect on metals, elastomers, plastics and wire coatings in new 21-page Freon Solvent bulletin, FS-1.—"Freon" Products Div., E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.

For more information circle **232** on inquiry card.

BACKLIGHTED DIALS AND PANELS using clear plastic laminated over printed markings are described for typical military uses in new 4-page bulletin. Second bulletin lists applicable Mil-Specs for Duralith and Duranyl processes.—Duralith Corp., 1025 Race St., Philadelphia 7, Pa.

For more information circle **233** on inquiry card.

HI-TEMP EPOXY for electronic and missile parts for temperatures to 500°F is described in data sheet.—Norrich Plastics Corp., 107-109 W. 18 St., New York 11, N. Y.

For more information circle **234** on inquiry card.